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EDITORIAL

Irrigation Unlimited

WHEN we wrote "Bread, not Stones" for this page a month ago, we had in mind irrigation and the Pacific Coast region only as a small part of a broad picture. Reaction to that editorial has been so vigorous that we must either take refuge in sudden silence, or continue with specific reference.

Readers who attended the meeting of the Pacific Coast Section of the American Society of Agricultural Engineers last February will remember that one speaker unfolded the alleged plans of a federal bureau for irrigation projects which would double the irrigated acreage in the state which already has one-fourth of all the West's irrigated land. They will remember that another speaker exhibited a sample of Sunday journalism wherein the head of a federal department was the apparent author of a plan to double the irrigated acreage not merely of a single state, but of all the western part of America.

In the single state first mentioned, if the cost were held within the figure mentioned, it would amount to some $130 per acre if charged to the newly watered land alone. If the cost were spread equally to other lands for which additional water is proposed, the cost would be about $90 an acre. Of course, these costs would not be prohibitive *if* (1) the soils were worth watering, *if* (2) there were remunerative markets for their products, and *if* (3) the lands were operated by men physically and mentally qualified for the exactions of irrigation farming.

According to competent authority, a large part of the readily irrigated land, suitable for irrigation farming, already has sufficient water. To double the area would result in putting water on marginal and submarginal lands from which it would be difficult, if not impossible, to make a decent living under the most favorable marketing conditions. Private enterprise has been justly criticised for its failure to consider fully the quality of the lands it has irrigated. Now, with all of the West's irrigation history as a guide, it would be nothing short of criminal for federal agencies not only to perpetuate these mistakes but, in the name of postwar relief for our fighting men, to go beyond the wildest ideas of private speculators.

Possibly it is unfair to consider costs in terms of agriculture alone, for the plan as unfolded also envisioned new electric power which would add more than 20 kilowatts for every man, woman and child, not in the adjacent region, but in all America. Be that as it may, the thing in which we are primarily concerned is the unfairness to our returned soldiers in the false hopes put forth in utter disregard of facts and history.

The time may come when the arts of agronomy will be able to coax from inferior lands enough production to make them profitable. There may be a time when the demand and price for farm products are high enough to justify the tillage of such lands even with their present low possibilities. No such time is in sight now. There is no reasonable hope that it will come in sight during the decade following the war, when there will be the problem of providing for war veterans. It would be a cruel prank upon them, and a fraud upon the American taxpayer, to embark on a program supported by such slender hopes.

Patriotism Can Be Practical

HAVING mentioned, elsewhere on this page, a certain meeting of the A.S.A.E. Pacific Coast Section, we may as well take note of some protests which arose therefrom. A few of our more sensitive souls took exception to branding as unpatriotic those who dared challenge the statistical soundness of proposals which, at least to the challengers, seemed grandiose. At the time, and from this distance, it appeared that the situation had been sufficiently softened by a prevailing spirit of tolerance, not to mention the sense of humor.

It would be unkind and unwarranted to recall Dr. Johnson's classic remark about patriotism being the last resort of a scoundrel. It is in order to reaffirm our belief that patriotism need not be blind and dumb. Indeed, it calls for courage of a peculiar strength to stand firm on technical and statistical grounds in the face of war hysteria, especially when it comes embroidered in brass and gold.

Now more than ever we need the vigorous clash of opinion, the hardy espousement of conviction, to make vivid the problems of our profession and their part in the destiny of our nation. The harder we shake the sieve, the more surely and more quickly can we screen out the best policy from among proposals which are not quite so good. It can and should be done without bringing into question the motivation of any man.

Dewater the Wiring

OUT of some correspondence between members of the American Society of Agricultural Engineers and the Adequate Wiring Bureau comes a case which visualizes a condition and a problem too long unsolved, if not too much ignored. In a barn 75 feet long were to be installed two strings of lights, involving six outlets, two snap switches, entrance switch and fuses.

A reliable supplier of wiring materials estimated their cost at $12 to $15, and of labor $10 to $15 if done by someone experienced in that type of installation. Compared with these total costs ranging between $22 and $30 a contractor offered an estimate of $100. In the judgment of the head of a department of agricultural engineering, familiar with the requirements, even the lowest figure was higher than necessary for a job which would be adequate and safe.

In comment on the general problem exemplified the other A.S.A.E. member, a man probably unequalled as to insight into the rural application of electricity, said "It is easy enough for us to tell farmers always to employ a licensed contractor, but that does not solve the problem. . . . . We can make idealistic recommendations which leave us in just the position we are now, which is not a good one; or we can face the painful fact that something drastic needs to be done about farm wiring which is entirely a distinct problem from city wiring."

Too infrequently we encounter legitimate electrical contractors or licensed electricians who have (or will admit) a concept of farm wiring as such. As a rule they seem reluctant to consider any but the most costly kind of code wiring even for conditions wherein it has been found definitely inferior. Their attitude lends credence to the cynicism of still another A.S.A.E. member who asserts that "the real purpose of *all* codes is to make things cost more."

To whatever extent there is substance in his cynicism, it would be futile to create a *(Continued on page 236)*

Above view shows one of the batteries of molding presses in the ORCO plant which covers more than 11 acres of floor space.

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AGRICULTURAL ENGINEERING

VOL. 25 JUNE 1944 NO. 6

Postwar Opportunities for Agricultural Engineers in Soil and Water Conservation

By T. B. Chambers

MEMBER A.S.A.E.

POSTWAR opportunities for agricultural engineers in the field of soil and water conservation offer a subject on which any of us can become prophetic without fear of correction until after the war is won. We may, however, examine some of the factors which will control such opportunities and from them arrive at certain reasonable conclusions. In speaking of opportunities I am sure we have in mind the opportunity of rendering service, individually and as a profession, to the full extent of our energies and capacities. Opportunities for engineers in this field will be tied closely with the development of the soil conservation movement in this country and no doubt the rate of development in the postwar period will be affected by the need for conservation work, the desire and ability of farmers to adopt soil and water conservation measures, and the facilitating services through which the required engineering and other technical assistance may be made available to the individual farmer or rancher. Such assistance, of course, will be affected to a considerable extent by the postwar demand for agricultural production. To those of us working closely with the soil conservation program, all indications as to postwar opportunities for agricultural engineers in this field are highly favorable. As things look now, there will be more opportunities than engineers.

Present consideration of the postwar needs for agricultural production in this country is important chiefly in preparing to combat the soil-depleting processes that are likely to be intensified by unusual export requirements. Many agricultural leaders believe that food from this country must be supplied to much of the conquered territory of Europe for several years after the war is over. The agricultural requirements for European relief may soon be more definitely determined by the newly created United Nations Relief and Rehabilitation Administration. The interbureau committee for postwar programs of the Department of Agriculture stated recently that . . . ."in general prospective exportable supplies of food are below prospective postwar requirements for all food except wheat, sugar, peas and beans." In addition to this unusual demand the normal needs for this country will require production from most of our agricultural land, a large part of which has already been seriously damaged by erosion and unwise farming practices.

Generally speaking, land use in the United States has not been guided by the capabilities of the land. As a result, erosion has made serious inroads, fertility of the soil has been reduced, crop yields have in many cases diminished, and the cost of farm operations has increased. Erosion resulting from improper land use has virtually ruined for further cultivation approximately 50 million acres of United States crop land, and has left another 50 million acres moderately or severely damaged. More than half the topsoil already is gone from 100 million acres of additional, and the process is now under way on a third 100 million acres. There are only about 75 million acres of farm lands in the country which are not subject to erosion, and this includes land now in crops, pasture, and in woodland.

The repairs of erosion damage and preventive measures against further depletion necessary to keep our land in sustained economic production will require a large amount of engineering and other technical services, if only to supply normal demands for products. There is now a greater demand for engineering services in this field than can be met under restrictive wartime conditions. Any increased demands for products due to exports or accelerated industrial activity in this country will add to this already large job for engineers in the soil and water field.

Of course, with a greater demand for products, it is logical to conclude that prices would be higher and the farmer would be in better financial position to carry on needed conservation work. On the other hand, with a smaller demand for products and reduced financial ability, the farmer would be forced to employ the more efficient methods of conservation farming to maintain profitable production. I am sure all of us are acquainted with the many increased efficiencies of farming operations that have been brought about in this country through improvements in farm machinery, fertilizers, insecticides, the development of superior strains of both plants and animals, harvesting and processing methods, and many other advancements. Until very recently, however, there has been little, if any, increased efficiency in the use of land. Land too steep and erodible for crops has been cultivated irrespective of erosion damage and reduced yields. Protective practices have not been used on lands that could have been farmed safely with them. We have not always understood that land unsuited for cultivation cannot be protected economically if cultivated, but the same land if used in accordance with its capabilities can safely be made to produce fair returns. We are only now beginning to realize the increased production that is possible by use of land in accordance with its capabilities and the employment of the necessary erosion-control and water-conserving practices.

At this point I would like to quote a paragraph from an editorial in AGRICULTURAL ENGINEERING for February, 1944: "There is bitter irony in the circumstance that the abundant life, nutritionally speaking, is possible only by the drudgery of men, women, and children who have no abundant life, nutritionally or otherwise. . . . Any sound solution must come not by paying people more than their product is worth but by enabling them to produce it in greater volume at lower cost." We may expect continued improvements in such items as farm machinery, fertilizers, and other things that will increase the efficiency of production, but I doubt if we can expect as much increased production per hour of labor from these methods as from the hours of labor required to install and maintain conservation

With the syrup-pan system of flood irrigation shown here, additional rainfall has been diverted onto the adjoining land for the benefit of the crops it will produce

This paper was presented at a meeting of the Southwest Section of the American Society of Agricultural Engineers at Dallas, Texas, March 10 and 11, 1944.

T. B. CHAMBERS is chief, engineering division, Soil Conservation Service, U. S. Department of Agriculture.

practices. As an example, it has been found in Nebraska, Iowa, and Illinois that the addition by contour cultivation of one inch of water to the average available soil moisture increased corn production from 5 to 7 bu per acre. Level terraces and contour cultivation on moderately level wheat lands in the southern Great Plains has increased production 3 to 5 bu per acre due to moisture conservation in all years except those with extremely low or high precipitation. The value of such practices for erosion control may be even greater in times of unusually high rainfall.

In the southeastern states a survey of 1,829 farms indicates an average increased return per farm for new crops of several hundred dollars, 1941-42 prices, due to the use of conservation practices for two or more years. In addition these same farms produced more of their regular crops on fewer acres of land.

Some idea of the extent of the job to be done, in order to assure efficient production and sustained yields in this country, may be gained by a brief review of our crop land status. For the four-year period, 1939 to 1942, there was an average of 346 million acres in crops. War needs increased this to 361 million acres in 1943 and it is estimated that 380 million acres must be put into crops in order to meet the 1944 production goals. The 1940 Census classified 398 million acres as crop land (Table 1). According to land-use capability classifications, 40 million of these acres are not suitable for crops and another 43 million acres are suitable for only occasional or limited cultivation. The work needed to patch up the scars on this 40 million acres of misused land and to install intensive practices on the other 43 million acres will be a high priority postwar job for engineers and other technicians.

LAND CAPABILITY SURVEYS ARE NEEDED

Of the remaining 315 million acres of crop land 45 per cent is class 3 land which requires complex or intensive conservation practices, 39 per cent is class 2 land which requires simple practices for sustained production, and only 50 million acres are class 1 land which can be farmed safely without special practices. It is apparent, of course, that with 380 million acres in crops more land will be improperly used and the future job of soil restoration will be correspondingly increased. The job of changing the use of these 40 million acres of land in accordance with its capabilities cannot be done quickly because land unsuitable for cropping is generally mixed in with good land, usually occupying only a few acres of a larger field. The only practical way to correct this situation is through individual farm plans, based on land capability surveys.

If this misused land is retired from cultivation, we have other lands that can be used more economically for crops. There are 166 million acres of class 1, 2, and 3 crop land that are now used for grazing and growing timber. Under our present economy it would be practical to change the use of about 102 million acres of this land to the production of crops. It is unlikely, however, that many of these needed adjustments will take place during the war. Much of this land requires clearing, drainage, or irrigation before it can be farmed. War limitations on labor, equipment, materials, and technical services will defer most of this job for postwar action. In all there are about 1 billion acres of land in the farms of the United States so that in addition to the problems on crop lands there is need for engineering assistance in correcting the problems encountered on other lands, though not to the extent found on crop land and grazing land.

Having discussed the extent of the conservation problem, it is worth our while to look into the size of the job that lies ahead for us as engineers. Tentative summaries have been made from a survey conducted by the Soil Conservation Service last year.

There are 95 million acres which require terracing for erosion control and moisture conservation. In Texas alone 18½ million acres need terracing. There are 634 thousand farm ponds needed for stock water, the production of fish for food, supplemental irrigation, and other purposes. Texas, Louisiana, Arkansas, and Oklahoma need 189,000 ponds. There are 6,300,000 acres of protected natural and artificial outlets required for disposal of surplus runoff from a large majority of the farms in the humid sections of the country. Two hundred seventy thousand, two hundred fifty miles of diversion ditches to divert water away from cultivated fields, gully heads, and other critical erosion areas would reduce soil losses tremendously. There are 577,000 dams needed for stabilizing channels and controlling gullies.

Water spreading or flood irrigation is an important practice for increasing forage on range areas and for controlling erosion, and there is need for water spreading on 2,300,000 acres.

One hundred thirty million acres require contour cultivation. Installing contour cultivation on the ground usually does not require the services of professional engineers. However, the development of criteria for adaptation and safe use of contouring under varying conditions of soil, climate, slope, and methods of farming may require engineering assistance in many places.

Stream bank protection is needed on 700,000 acres of stream banks. This problem is important in parts of the country where meandering streams are destroying the only crop land available.

The rehabilitation of existing drainage systems and installation of adequate farm drainage is an important job for present and postwar engineering. There are at the present time 24,600,000 acres of cultivated land in organized drainage districts which produce little or nothing due to poor drainage. Of these 2,544,000 acres are in Arkansas, Louisiana, and Texas. The cost of correcting the drainage problems on this land is well within economic limitations. Most of this land is not subject to erosion and with adequate drainage it can be farmed more economically than steeper lands that are subject to erosion. The increased yields that good drainage would provide are needed now and much of this work would move forward rapidly except for the lack of engineering assistance, construction machinery, and labor.

In addition there are 6,400,000 acres of fertile, cultivated lands outside of organized drainage enterprises which can be drained economically. Draining some of this land will require much time for planning and organizing drainage districts, but much of it is in small tracts that lend themselves to action through informal associations that can move ahead rapidly when engineering and other assistance becomes available.

Placing the drainage systems in acceptable working order by no means completes the engineering work, however, for individual farm drainage problems will also require engineering assistance. Lateral drains will need to be extended to individual farms and groups of farms and new tile or open drains will be required on many fields. Many existing farm drainage systems are in bad repair and must be improved or revised for efficient operation.

DISTRIBUTION SYSTEMS REQUIRE REHABILITATION

The 1940 Census listed 91,637 individual irrigation enterprises supplying water for 20½ million acres of land in the 17 western states. Information available to the Soil Conservation Service indicates that the systems supplying water to 11,700,000 acres are in need of repair and that many of them require improvements of a permanent nature to reduce maintenance costs and increase efficiency in the delivery of water. Like the larger irrigation systems many of the individual farm distribution systems require rehabilitation or revision for economic use of water and labor.

Of significance at this time is the increasing interest in supplemental irrigation of farmers in humid sections of the country. A farmer in Georgia recently requested the Soil Conservation Service to prepare plans for gravity irrigation of 120 acres of alfalfa and vegetables. The water supply is to be developed by storage on a small stream, and if the operation is successful an additional 300 acres will be irrigated for corn and general crops. It is noteworthy that this land was recently drained. This farmer is convinced that the combined operation of drainage and irrigation will pay profitable returns. Supplemental irrigation of specialty crops is on the increase and more farmers are requesting assistance for the installation of new systems.

Citrus-grove irrigation in Florida is rapidly becoming one of the major operations in citrus-fruit culture. While the citrus belt of Florida has a normal annual rainfall of around 50 in, which is in excess of the total annual need of citrus trees, a large percentage of groves suffer from lack of moisture at some time or other during the spring or fall for 5 out of 7 years due to inadequate distribution of rainfall. About one-third of the citrus in the state is irrigated and much of the remainder would benefit by irrigation. There are many problems involved in the irrigation of Florida citrus that differ from those of other citrus-growing sections. Engineers can make a valuable contribution in the solution of some of these problems.

Agricultural engineers will be called upon in the postwar period to control erosion along our highways. There are over 332,000 miles of trunk line highways in the United States and 2,600,000 miles of secondary and feeder roads, on many of which roadside protection is needed. The Soil Conservation Service, cooperating with the Public Roads Administration and several state highway departments, has assisted in installing demonstrations along 200 miles of trunk roads and several hundred miles of county and township roads have been treated. These demonstrations or test sections have clearly shown the value of roadside erosion control work for efficient maintenance, pleasing appearance, and increased safety of travel. Many road departments will undoubtedly carry on this work in their postwar operations.

CONTROL OF SILTATION OF RESERVOIRS IS PROBLEM

The improvement of watersheds to control the siltation of reservoirs is another problem for engineers in the soil and water field. In many cases damage is rapid and serious and some early postwar work may develop, particularly in connection with the water supply of municipalities. It is estimated that about 26 million people obtain their domestic supply from 2,700 reservoirs. Many communities have taken steps to provide watershed protection as a safeguard for their water supply. In every state in New England some communities have acquired part of the land from which they obtain water. Cities and towns in Massachusetts own more than 50,000 acres in watershed forests. Forty towns in Vermont possess municipal forests, largely for watershed protection. Some 350 communities in New York own municipal forests, and many other examples of public ownership of watershed lands can be cited.

In 1936 a Soil Conservation Service survey showed that Lake Decatur, constructed by the city of Decatur, Illinois, at a cost of $2,013,000 had lost over 14 per cent of its original capacity in a little more than 14 years. Two soil conservation specialists were hired as full-time city employees to assist a local conservation association in the development of erosion control measures designed to protect the life of this important reservoir. The city of Waco, Texas, is actively cooperating with a soil conservation district in promoting a program of watershed protection to safeguard its water supply. Studies made at High Point, North Carolina, showed that the rate of silting in the water supply reservoir was reduced 34 per cent as a result of watershed protection installed through the efforts of a Soil Conservation Service demonstration project.

While this discussion has centered largely on the opportunities for planning and installing corrective measures, the opportunities for engineers in the field of research should not be overlooked. Investigations of the fundamentals of erosional processes and methods of correcting them must continue to support the planning and action phases. The progress to date in developing action programs is largely the result of important findings of the research workers. Much more basic data are needed now on the factors affecting runoff from small agricultural watersheds, on more efficient design of water-control structures, on the efficiency of vegetation for channel lining under varying conditions of soil, slope, and climate, on water and pumping requirements for irrigation, to mention only a few. Investigations covering these subjects are under way now at various state and federal experiment stations but postwar activities unquestionably will stimulate such research by engineers.

The conservation program will provide many opportunities for engineers in the adaptation and use of construction and farming machinery for building conservation structures. Harvesting, curing, and processing problems, resulting from the introduction of new crops in a conservation program will require engineering assistance. For example, an experimental plant was constructed last year near Hamilton, Georgia, for processing kudzu hay into mixed feeds. While the process is similar to that used for alfalfa, new techniques were necessary in cutting, loading, and drying this hay which is characterized by long, tough runners. Operation for one season has been satisfactory and there is a possibility that an industry may be built up around this important erosion-control plant, of which 296,500 acres have already been established in the southeastern states, largely on severely eroded land.

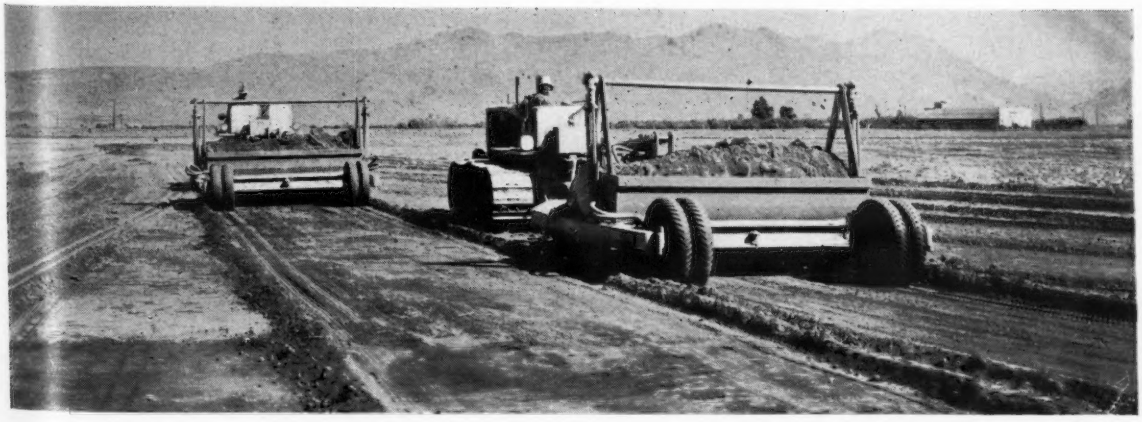
Currently there is a reduction in engineering graduates from our colleges due to the war. This deficiency will need to be corrected promptly in the postwar period and engineering instruction in schools and colleges will provide many opportunities.

With this summary of the extent and nature of the job as it now appears, we should examine briefly the attitude of farmers towards conservation work. Unless the farmer has a lively interest in conservation and a desire to adopt conservation practices on his farm, very little work will be done. Fortunately, there is intense interest on the part of many farmers in conservation methods, a fact that supplies the best evidence for optimistic conclusions.

SOIL CONSERVATION DISTRICTS INDICATE FARMER INTEREST

The most significant indication of farmer interest is probably the development of soil conservation districts. Beginning as a nationwide movement in 1937, the first district was organized under a state enabling act in North Carolina in August of that year. On January 15, 1944, 989 districts had been organized in 43 states. These districts include 2,539,584 farms, covering 563 million acres. In addition, two other states, Missouri and Rhode Island, have recently enacted a soil conservation district law, leaving only Massachusetts, New Hampshire, and Connecticut without enabling acts.

The districts are organized through democratic processes and reflect the interest of the farmers in conservation work. Some of the state laws require considerably more than a simple majority of the votes cast in referenda for the organization of districts. For example, fifteen states require a majority of 60 to 67 per cent of those voting, and several states require a certain percentage of the acreage in the district to be favorably represented in the votes cast. Nebraska requires a 75 per cent majority of the landowners voting and Kansas requires a 75 per cent majority of the landowners and non-owner operators voting. Even with such high requirements, 43 districts have been organized in Nebraska and 26 in Kansas.



Leveling a 40-acre field (Tulare Co., Calif.) of virgin soil in preparation for a cotton crop to be grown under irrigation

The Soil Conservation Service is cooperating with 892 of these districts. Conservation plans have been made on about 200,000 farms in districts and the work under these plans is about 45 per cent completed. The requests from farmers for technical assistance far exceed the resources of the Soil Conservation Service and other cooperating agencies at this time. Some district governing bodies have recently curtailed the educational activities of technicians in order that more time may be spent in meeting the requests of farmers for planning and installing their conservation practices. In addition to the technical services regularly made available to districts for work on individual farms, many of the districts are now requesting specialized engineering assistance on group drainage and irrigation problems.

Members of this audience are no doubt interested in the fact that in the states of Louisiana, Arkansas, Oklahoma, and Texas 209 soil conservation districts have been organized as of January 15 of this year.

While the same patriotic motives that have impelled farmers to break all previous records of crop production have also influenced the adoption of conservation methods, it is mainly economic interest that will assure a continued and expanding program of conservation in this country. Unless conservation pays the farmer a fair return for his effort, he will not continue its practice without subsidy. If he receives a fair return, subsidies will not be needed.

Many examples could be cited of increased yields due to the effect of applied conservation methods. Such figures have been widely published and need not be repeated here. I will, however, give you some of the results from a farmer opinion survey just completed by the Soil Conservation Service. In this survey farmers were requested to state the effects on their farms on production after practicing conservation for at least 3 years as compared to production on the same farm for 3 years prior to the adoption of a conservation plan. From 47 states 9,244 farmers, representing 3,911,665 acres, estimated that for these farms the production was increased 33.5 per cent for all crops. By Sections of the country the figures are: (1) Northeast, 33 per cent; (2) Southeast, 40.4 per cent; (3) Upper Mississippi, 25.6 per cent; (4) Western Gulf, 35 per cent; (5) Northern Great Plains, 35.1 per cent; (6) Southwest, 27.7 per cent; (7) Pacific Coast, 21.3 per cent.

There were 2,971,720 acres in production after conservation plans were installed. The increase of 33.5 per cent is equal to an added equivalent of 995,000 acres. It is interesting to note that 1,380,000 more bushels of corn were produced on 32,000 less acres, 14,705 more bales of cotton on 2,890 less acres, and 778,000 more bushels of wheat on 2,500 less acres. These farms also produced 22 per cent more beef cattle, 27 per cent more dairy cattle, and 53 per cent more hogs. In addition a majority of these farmers said that the use of farm machinery and their labor requirements had been reduced.

OPINIONS OF FARMERS ON SOIL CONSERVATION

Of interest also is the reply to the following general questions designed to bring out farmer opinion on soil conservation, as expressed by more than 3,700 farmers in Texas, Louisiana, Arkansas, and Oklahoma:

1 Do you believe that the soil conservation practices applied on your farm have been effective in controlling erosion? Yes, *3,716;* no, *40.*

2 Have the conservation practices applied on your farm been effective in increasing production? Yes, *3,664;* no, *92.*

3 Were weather conditions during the crop seasons for the indicated "before" period good (*574*), fair (*2,870*), or poor (*312*)?

4 Do you know of any farmers who have applied one or more soil conservation practices as a result of seeing these practices in operation on your farm? Yes, *2,356;* number of farmers, *12,029;* no, *1,357.*

5 Have you assisted any of your neighbors to install soil conservation practices on their farms? Yes, *1,528;* number of farms *6,857;* no, *2,218.*

6 Has the conservation program, as applied on your farm, brought about a saving in labor and use of farm machinery? Yes, *1,932;* no, *1,689.* If yes, estimate average annual cash value of these savings (*$68.06*).

In order that all the opportunities for engineers in the soil and water field be fulfilled, it is necessary that the agencies which supply engineering and other technical services to farmers be supported in proportion to farmer interest and the needs for the work. All of you are familiar with the work that has been carried on in this field by the Soil Conservation Service, extension service, the state and federal experiment stations, Forest Service, and other agencies. All of these agencies will probably find their facilities extended to the limit to supply the demands for farmer assistance on soil and water problems in the postwar period. Appropriations to the Soil Conservation Service have been reduced since the war started. It is not questioned that this reduction was in keeping with the total national needs for war, nor is it probable that all of the engineers needed could have been employed, even had there been sufficient funds, because of the critical need for engineers in other fields. This reduction in funds and shortage of available engineers leaves the Service with many vacancies at this time, but it is hoped that funds will be made available for quickly correcting this deficiency once the war is won.

The public agencies must not encroach on the field of the private engineers. There is plenty of room for both and their respective fields can be defined clearly in most cases. Private engineering services to individual farmers on a full-time basis has rarely been a satisfactory arrangement, but there are many opportunities for private engineers to serve organized groups of farmers, such as large drainage and irrigation enterprises. The public agencies are equipped with facilities for in-service training and research investigations and can provide for free exchange of experiences between technical groups working on common problems that are not always available to the private engineer.

IDEAL CHANNELS FOR CARRYING TECHNICAL SERVICES

The experience gained in working with soil conservation districts indicates that these organizations are ideal channels through which technical services, provided by public agencies, may be carried to farmers. The soil conservation district develops a work program and sets up priorities for carrying out the various items of the program. Services from cooperating agencies are requested in accordance with district needs and are made available to individuals on a basis determined by the district governing body. The advantages of such an arrangement to both the farmer and the agency are readily apparent.

Soil conservation districts are engaged at this time in making plans for postwar work. It is expected that these plans will set up, among other things, priorities on specific jobs to be done, the amount of equipment needed for installing soil and water practices, conservation material requirements, and the amount of engineering and other technical services needed. Completion of these plans will permit the districts to move ahead as rapidly as the needed facilities are available.

TABLE 1. CROPLAND POSSIBILITIES OF LAND IN FARMS IN THE UNITED STATES ACCORDING TO LAND-USE CAPABILITIES

Present use	Total acreage	Suitable for crops but impracticable to change present use	Not suitable for crops	Suitable for crops
Cropland	398,000,000*		40,000,000	358,000,000
Grazing lands	132,000,000	64,000,000†		
Woodlands	34,000,000			102,000,000
Totals	564,000,000	64,000,000	40,000,000	460,000,000

*1940 Census.

†Land in woodlots and pasture lots or requiring expensive drainage or irrigation practices.

TABLE 2. LAND-USE CAPABILITY CLASSES OF LAND IN FARMS OF THE UNITED STATES SUITABLE FOR CROPS*

Present use	Total acreage	Class 1	Class 2	Class 3	Class 4
Cropland	358,000,000	50,000,000 (14%)	124,000,000 (35%)	141,000,000 (39%)	43,000,000 (12%)
Grazing and woodland	102,000,000	12,240,000 (12%)	31,620,000 (31%)	58,140,000 (57%)	
Totals	460,000,000	62,240,000	155,620,000	199,140,000	43,000,000

*Land suitable for cultivation:

Class 1 Without special practices
Class 2 With simple practices
Class 3 With complex or intensive practices
Class 4 Suitable for occasional or limited cultivation.

Sweet Potato Dehydration

By Harold T. Barr and Leland E. Morgan
MEMBER A.S.A.E. JUNIOR MEMBER A.S.A.E.

SWEET potatoes constitute the most important vegetable crop in the South. Their production for food, feed, and industrial utilization is an agricultural enterprise of increasing importance. Because of its high percentage of carbohydrates and carotene and its adaptability to many processing requirements the sweet potato has acquired local and national prominence during the war emergency. Except for the Maryland, Delaware, and New Jersey area, most of the country's crop is produced in the South.

Louisiana harvested 119,000 acres of sweet potatoes in 1943 which yielded approximately 8,000,000 bu with a valuation of $15,000,000. The United States produced approximately 72,500,000 bu of sweet potatoes in 1943. Louisiana shipped by car and truck last year over 7,000 cars of sweet potatoes for the fresh market, according to figures supplied by P. T. Ecton, extension marketing specialist for Louisiana. About 30 per cent of the average crop is culls and low-grade potatoes which should be manufactured into feed. Another 30 per cent is of such quality that it should be taken off the fresh market and used for processing as food either by freezing, canning, or dehydration. By taking all of the off-grade potatoes off the market the demand for a better grade of table stock would be increased.

The recent changes in wages, due to wartime conditions, have increased the cost of production by about 75 per cent. Horse equipment and hand methods of setting and harvesting the crop require about 140 man-hours per acre. This represents almost one-half of the total expense. Of this 140 man-hours, 25 is required for transplanting and 60 for harvesting. The increase in farm wages from 15c per hr six years ago to 25c or 30c per hr now makes a considerable difference in labor costs.

Using horse equipment on a small acreage basis, the cost per acre for growing sweet potatoes is about $80 or $90 for a 200-bu yield which is common in areas that produce potatoes for dehydration. This means a cost of 40c to 45c as compared to 25c per bu a few years ago.

More extensive development and use of mechanical diggers and pickers, together with tractor plowing and cultivation, will do much to reduce the cost of production. The man-hours is dropped from 140 to 60, reducing the total cost per acre about $20. The cost of use of equipment is of course greater for the mechanized farmer. However, this item is relatively small compared to the cost of man-hours of hand labor.

This paper was presented at a meeting of the Southwest Section of the American Society of Agricultural Engineers at Dallas, Texas, March, 1944.

HAROLD T. BARR and LELAND E. MORGAN are, respectively, head of agricultural engineering research and assistant agricultural engineer, Louisiana Agricultural Experiment Station.

On test plots of the Louisiana State University horticulture department, the L 4-5 starch sweet potato produced 780 bu per acre. This yield is not common among the growers; however, it indicates the probability of higher yields when this potato is grown extensively for feed or industrial purposes. The seed of this variety is being increased and within the next four years it will be widely grown.

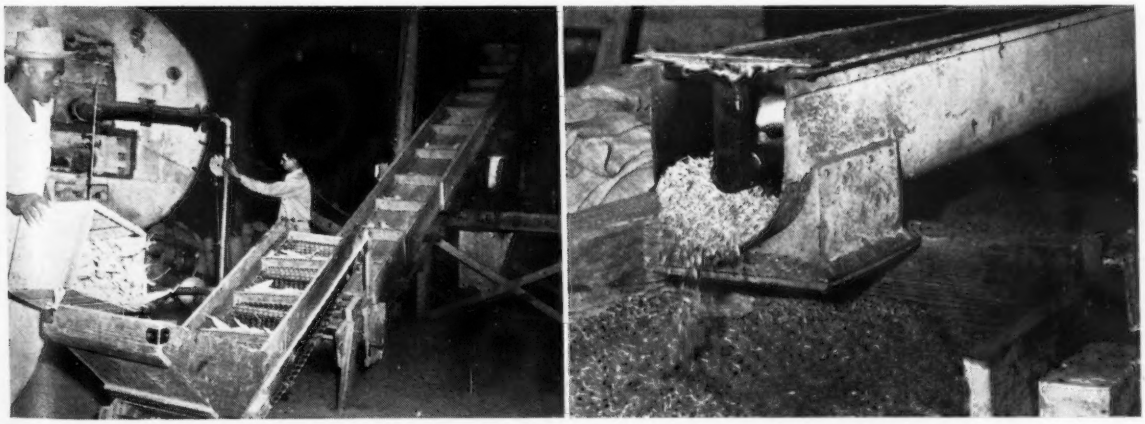
This past season one food dehydrator contracted for potatoes at $1.25 per hundredweight. A yield of 170 bu of No. 1's and 2's gave a gross profit of $112.50. The net profit was about $32.50 per acre, plus about 1,500 lb of culls and cracked jumbos which could have been sold to a feed dehydrator for from $6 to $12 per ton, depending upon the price of feed at the particular time. This contract was probably the lowest that any grower received; however, they were able to realize a profit. Many No. 1 potatoes were sold to shippers and dehydrators for from $3 to $5 per hundredweight.

As the total acreage of sweet potatoes in this country is small compared to cotton or corn, likewise the development of field machinery has been small. For a home-use crop of one acre or less it would not be economical to attempt extensive mechanization. However, with as much as 30 acres per farm, as many growers now have, it is becoming necessary to develop better equipment.

The usual method of growing sweet potatoes where the acreage is small involves many hand operations. With mule equipment it is assumed that hand transplanting will be practiced and, because of the small acreage, fertilizer is not purchased for the crop. The sweet potatoes are cultivated once or twice and hoed once. The greatest single operation is the harvesting which requires about 60 man-hours per acre.

Many of the transplanters being manufactured commercially can be used for setting sweet potatoes, and also the preparation of the soil and later cultivations can be done with standard equipment. The harvesting then stands alone as the one job which defies larger acreage unless it can be mechanized to such an extent as to greatly reduce the man-hours. The conventional mechanical Irish potato harvester and picker (for sacking the potatoes) can reduce the harvesting time for a 200-bu per acre yield from approximately 60 to 10 man-hours per acre. The harvesting cost is reduced from about $18 to $5 per acre. Approximately 60 per cent of the 1943 acreage of roughly 1,000,000 acres could have been handled mechanically.

Before the mechanical digger can be used it is necessary to remove the vines. The sugar-cane stubble shaver has been used very satisfactorily but it is not economical to purchase one for less than 50 acres. A sled, similar to a corn sled, is very simple to construct



(Left) Arrangement of a preparation line for feed sweet potatoes. The crates are emptied into a conveyor which elevates them to the shredder. The first short chain conveyor allows the dirt to fall through. The shredded sweet potatoes are conveyed from the bottom of the shredder to a funnel chute above the drum. To the left is the burner end of the furnace with two burners and automatic recording dial temperature controller • (Right) Dried shreds of feed sweet potatoes as they are removed from the rotary drier by a screw conveyor

and is very efficient in cutting and dragging the vines off the rows. When sweet potato vines are turned under they provide a wintering-over home for the sweet potato weevil. For controlling the weevil, it would be much better to remove all of the vines. The sweet potato vines will give from one to two tons of dry feed per acre which according to unpublished results of the Louisiana State University horticulture department would be approximately equal to that of alfalfa hay. In feed value the sweet potato vines analyze as shown in Table 1.

TABLE 1. A COMPARISON OF SWEET POTATO VINES AND ALFALFA HAY

Type of hay (Dry basis)	Per cent protein	Per cent fats	Per cent carbohydrates	Per cent mineral matter
Sweet potato vines	12.6	3.3	45.5	10.2
Alfalfa hay	14.7	2.0	36.4	8.3

In order to remove the vines for hay, various machines and forage harvesters are now under examination. The rotary dehydrator will handle the vines turning out an excellent pea green feed.

In 1942, approximately $487,000,000 was spent for mixed feeds, carbohydrates mainly, which were sold under the feed inspection services of the 13 southern states. It is estimated that roughly 50 per cent of this feed was imported from other states. In the South, at least, the sweet potato exceeds all other crops in potential carbohydrate production per acre. This factor presents itself as a means of overcoming some of the importation of feed from other parts of the country and for building up a better livestock enterprise in the South.

In Louisiana, April and May plantings are recommended where the sweet potato is to be used for industrial uses such as feed and starch dehydration and for early market shipments. Early plantings definitely produce higher total yields than later plantings; however, those made during June produced the highest percentage of fancy marketable potatoes. Plantings of sweet potatoes made in April, May, June, and July, and harvested in October, produced decreasing yields in bushels per acre at the rate of 100 bu per month (25 bu per week) from a maximum of 450 bu if planted in April and harvested October 15.

TABLE 2. EFFECT OF DATE OF PLANTING ON YIELD OF SWEET POTATOES DUG OCTOBER 15*

Variety	Date of planting	Yield in bushels per acre	Moisture per cent	Sugar, per cent Reducing	Sugar, per cent Total as invert	Starch, per cent
	April	449.4	68.7	0.15	1.75	22.2
Triumph	May	345.9	67.7	0.14	1.54	22.5
4-yr avg	June	239.3	68.3	0.16	1.60	22.5
	July	99.4	68.6	0.14	1.57	21.6
	April	497.6	63.74	0.71	1.71	26.5
L 4-5	May	401.6	65.09	0.26	1.69	25.4
2-yr avg	June	316.7	66.00	0.30	1.63	24.3
	July	183.5	67.20	0.32	1.54	23.0

*Data from Louisiana Bulletin 348, entitled "Studies of the Production of Sweet Potatoes for Starch or Feed Purposes," by W. D. Kimbrough, June, 1942.

As sweet potatoes come out of the field they cannot be kept for a very long period without partial or complete loss unless stored in a specially equipped room. When stored fresh, the sweet potato must be handled carefully and housed where the temperature never goes below 50 F. In this fresh form the sweet potato also takes up a large amount of space and is continually breaking down internally. It is interesting to note that sweet potatoes will heal a cut but not a bruise. Dehydrated sweet potatoes for feed will require approximately one-third the volume of fresh potatoes, a cheaper storage bin, and they have been kept two years without any appreciable loss.

Studies on sweet potato dehydration at Louisiana State University have been carried out on single-drum, parallel-current rotary driers. To date no tests have been made on counter-current rotary driers, but a drier is now being constructed for such tests during the next season.

The quality and appearance of the feed produced from dehydrated potatoes are affected materially by the preparation of the fresh product before drying. After digging, the sweet potato should be cleaned of all dirt by brushing or washing; otherwise it will be ground into the potatoes during shredding producing a low-quality feed, and one small rock may damage the shredder knives beyond repair. The potatoes are conveyed, after cleaning, to the machine where they are shredded into particles varying from 3/16 to ¼ in square. The size of shredding is governed by the particular beet shredder knife used. The beet shredder knives are obtained from Henry Disston & Sons, Inc. Shredder knife No. 9-36 gives the thinnest shred, but knife No. 8-24 has proven satisfactory. Plans for shredders may be obtained from the Agricultural Engineering Department of Louisiana State University, Alabama Polytechnic Institute, or the Tennessee Coal, Iron and Railroad Company.

During the past season it was found that data and operating characteristics of one drier could not be applied entirely to a second drier which varied slightly in some of its construction. Typical operation of one drier is shown by the data in Table 3. These runs were of sufficient length to be of an average capacity under the conditions used in each test, as each test used eight tons of raw sweet potatoes. From the results of these tests, it was found that much higher temperatures can be used than had formerly been recommended. The higher temperature with its corresponding heavier feed of raw sweet potatoes resulted in a larger capacity and thus a lower operating cost per ton. There were no appreciable differences in the analyses of the final dry products from the various runs. For this reason the first run was best since it gave a capacity of 2260 dry pounds per hour at an actual operating cost of $4.12 per dry ton.

TABLE 3. SWEET POTATO DEHYDRATION

Direct-Heat, Gas-Fired Rotary Drier (46 ft long, 7 ft diameter), Without Recirculation

Item	Runs 1 L 4-5 Starch potato	2 L 4-5 Starch potato	3 Porto Rico	4 L 4-5 Starch potato
Rate of feed, lb/hr	6,135	3,480	3,274	3,410
Rate of gas consumption, cu ft/hr	5,657	4,670	5,050	4,320
Rate of electric consumption, kwhr/hr	17.8	18.3	17.7	15.7
Rate of air flow, ft/min	333	333	333	367
Rate of moisture evaporation, lb/hr	3,220	1,925	2,240	2,105
Water evaporation per 1,000 Btu, lb	.569	.412	.444	.488
Dry products*, tons/hr	1.13	.663	.471	.608
Initial moisture content, per cent	62	62	70	64
Final moisture content, per cent	5.36	5.26	5.12	6.15
Temperature at furnace end of rotary drum, avg F	1709	1386	1391	1502
Temperature at exhaust end of rotary drum, avg F	220	220	222	222
Operating cost†: per hour	$4.65	$4.69	$4.77	$4.55
per dry ton	4.12	7.08	10.13	7.49

*The time unit is based on the time of feeding fresh potatoes into shredder.

†Does not include cost of raw material, depreciation, interest, taxes, management, or repairs.

The Porto Rico variety having a higher initial moisture content gave more trouble from sticking to the hot end of the drum at 1400 F than the L 4-5 did at 1700 F. The L 4-5 had an average moisture content of 62 per cent and Porto Rico 70 per cent. Final moistures of approximately 5 per cent as obtained in these tests may be a little lower than necessary as they gained back to an average of 8 per cent while stored for 30 days in sacks.

The dehydrated sweet potatoes without further grinding have been found by our dairy department to be equal to 90 per cent of corn in the concentrate mixture.

At one dehydrator the farmers can have their sweet potatoes processed on a toll or cash basis. They are all paying cash for the processing and using the feed for mules, cattle, hogs, and chickens. Processors could afford to pay the grower $6 to $12 per ton for the raw sweet potatoes for converting into feed.

An additional use for dehydrated sweet potatoes in the making of industrial alcohol has received considerable attention in the past few months. Two lots of dehydrated sweet potatoes which were dried under our supervision were later converted into industrial alcohol by Joseph E. Seagram & Sons, Inc. On full-size plant operation, one 56-lb bushel of dehydrated L 4-5 potatoes yielded 5.44 proof gallons of 190 proof alcohol. The basis of this alcohol yield gives a very favorable picture of dehydrated sweet potatoes as compared to corn, wheat and kaffir corn. *(Continued on page 216)*

Farm Service Buildings—Assets or Liabilities

By Ray Crow

MEMBER A.S.A.E.

A FARM building or other structure that does not pay its way is a liability. To pay its way the presence and operation of the structure on a farm must increase that farm's income by an amount that will at least maintain the structure and amortize its cost during its useful life. Any sum realized above this minimum is net profit to the farm operations. If there is no net profit realized, the structure certainly is not an asset and something should be done about it.

Unfortunately, however, farm structures are seldom predicated on this basis. Too often they are based on personal whims, prejudices or structures built elsewhere, rather than on actual studies of what is specifically needed. In such cases the individual responsible for the design will be loath to admit any inadequacy, and since this is often the owner the structure will be continued in operation with attendant unnecessary loss.

Or, the structure may be built down to a price rather than up to a performance. The daily saving of one hour of chore labor at 25c per hr will amortize an initial investment of $1500 at 5 per cent interest over a period of 30 years. The efficient expenditure of much less than $1500 for labor-saving devices or arrangements in the construction or remodeling of an otherwise conventional but sizable farm structures layout generally can be made to save one chore hour per day. Yet how many farmers, or farm structures engineers for that matter, design on this basis. An engineer in industry that failed to take such items into account in designing housing for industrial manufacturing plants would not get very far.

Many farm structures designers think of service buildings primarily as conventional adjuncts to rather than active components of the farm operations. That is, the buildings are desirable as shelters from the weather thus adding somewhat to the comfort of animals and operators, but actually contribute little or nothing in the way of increased income.

One reason for this attitude is that structures are static. The results of their operations are not so readily subject to analysis and quick evaluation as are the dynamic operations of farm machinery, electric equipment, or even the increased yield of a farm crop due to an improved system of culture and fertilization. It is not realized that efficient farm structures round out and complement the entire farm operations by being instrumental in preserving and retaining at least a large part of the gains made by breeding better and more efficient grades of livestock; producing more prolific and nutritious grains, hays and other livestock feeds, or the increased yields of commercial crops brought about by soil improvement and better cultural and harvesting methods.

It is possible to raise poultry in most areas of the South without any structures erected for that specific purpose. Domestic fowls are yet so near the wild state that instinct impels them to roost in trees, on fences or in other as nearly safe locations as they can find, when permitted to run loose. However, if this system of poultry production were followed exclusively throughout the country, the farmers of the nation would not have been able to sell chickens and eggs to the net cash value of well toward $400,000,000 as was the case in 1939 according to a U. S. Census report. Somewhat similar analogies could be made for other branches of livestock production.

This paper was presented at a meeting of the Southeast Section of the American Society of Agricultural Engineers at Atlanta, Georgia, February, 1944.

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Well-designed, economical buildings serve not only as shelter for livestock and storage for crops but also contribute directly to increasing farm income

All agricultural engineers can agree that farm structures are essential to enable the farmer to produce sufficient livestock and livestock products to supply the total consuming needs of the country, and if that is so then certainly their design, construction, and operation deserve as careful study and consideration as any other phase of farm operation. Unfortunately these aspects are often disregarded.

A farm building may fail to pay its cost in various ways. It may give so little protection to its contents that it has no real value for this purpose. It may be so inconveniently arranged as to require excessive labor for operation. Or it may be so expensively built that the amortization cost is out of line with the profits that it makes.

An example of the latter was disclosed within the last year or so in a southeastern state. Due to the location of army camps the demand for graded milk was increased materially. A wholesale dairyman undertook to encourage farmer producers of ungraded milk to change over to classified production, and other farmers to enter this type of dairying. He found prevailing a general widespread impression that the minimum cost of building and equipment necessary for such production was at least $2,000. The average value of the farm herds was no more than this and the owners did not feel that such an expenditure was justified.

But this dairyman was housing and milking his own herd of thoroughbred cows valued at $40,000 in a structure worth not more than $2,000. Why was it necessary for the owner of a small herd to have an equal investment in structures and equipment? He found that it wasn't. He put the problem up to the head of the agricultural engineering department of the state agricultural college of his state and the result was a $675 barn (wartime cost) that complied with the health department regulations. Even this penalizes the small producer seriously. The overhead cost of an investment of $675 to provide such facilities for a $2,000 herd is proportionately far greater than is one of $2,000 to provide such facilities for a $40,000 herd.

Under the circumstances, the engineer in question did a good job, promptly and efficiently. This is evidenced by the fact that although the plan was drawn up practically overnight, few changes have been made in the original design. Yet the fact remains that it took a war and the instigation of a commercial operator to develop the fact that a minimum-size, graded milk producing structure could be erected for approximately one-third the cost that had previously been considered necessary. Does it seem necessary to have a war to stimulate such an extremely desirable development?

Many farm service buildings do not pay their way through no fault of their own. For instance, the income from the sale of milk from a herd of scrub cows probably will not be sufficient to pay for even the feed consumed, to say nothing of the labor and overhead involved, even though housed under ideal conditions and given the best of care. Such a herd is in itself a liability and any structures built for it simply increase that liability. On the other hand, a herd of high-producing cows may, within certain limits, increase milk production sufficiently in proportion to feed and labor requirements to warrant a considerable increase in cost for better buildings.

However, the determination of the limitations mentioned are important factors. It is an easy matter to design and build a good dairy barn if cost is no object. I inspected a new group of buildings of this type some three years ago,

built by a nationally known firm that specializes in such work, to accommodate a herd of 175 cows for a wealthy business man who farms on the side. The proud owner assured me that the cost was only $50,000 all complete, including three dwellings for workers. This is just under $300 per cow, approximately one-third the total value of the complete building layout including the residence on the average southeastern farm.

Possibly the operation of this particular herd can show a profit even when burdened with such a capital charge. My considered opinion is that the structure is largely a liability in the sense that one-third to one-half this investment could have been made to serve equally well. Contrast this with the previously mentioned case of a highly successful commercial dairyman who milked and cared for 120 cows in a barn valued at $2,000, amounting to less than $20 per cow.

Somewhere between such extremes lies a point of greatest net income efficiency. To determine it is not an easy task. It requires the application of much more than merely engineering talent and structural skill. There must be a coordination and correlation of information pertaining to all the activities of the particular farm in question. Yet how often do those of us who are interested in design and construction receive postcards saying simply "Please send me plan for a 40-cow dairy barn". Not a word of explanation as to the type of herd to be housed; what feeding practices are considered; what part, if any, of the feed is produced locally; whether graded or unclassified milk is to be produced; no information as to whether this is for expansion of present operations or a new venture; no data as to the dependence on pasture, or, in fact, anything except that a structure is desired. The worst way to answer such a request is simply to pull out of the files a copy of some plan on hand that comes nearest to what the inquirer appears to think he wants, and mail it.

CLOSER LIAISON AMONG VARIOUS SPECIALISTS NEEDED

It may not be at all the type of structure he should erect for his particular needs. Yet he may build it and unwittingly be stuck with a liability for years to come. The best course is to refuse to furnish any plan without more information. This illustrates both the opportunity and responsibility not only of the structures specialists among agricultural engineers but also that of other specialists as well. There should be a much closer liaison among all these various specialists with respect to structures than generally exists. Furthermore, the specialists along any particular line in regional areas in which similar climatic and farming conditions exist should in some way get together on recommendations for functional requirements of farm structures. This would assist the structures men materially in reducing the number of structural liabilities.

A start has been made in this direction by the U. S. Department of Agriculture. A couple of years ago a group of building material producers submitted a request to the Department to supply the public with average functional standards for poultry houses, hog houses and dairy barns based on climatic zones throughout the country. The first response was that these data already existed. Later it was conceded that they did not, but the subject was considered sufficiently important to have committees appointed from among the specialists of the Department to draw up such functional standards for each of the three types of structures. At the end of two years the recommended standards for the hog house have been completed and the others are well under way. This information will tend to produce better service buildings but is not the complete answer.

My observation indicates that throughout most of the southeastern states the tendency is to overbuild for livestock shelters but to underbuild for labor-saving devices, conveniences for the animals and the operators, and (very definitely so) for storage and processing buildings as well as for fencing layouts. I consider the latter of prime importance as assets.

Properly arranged and efficiently operated fenced fields and pastures which permit convenient rotation, and direct harvesting of crops by livestock will quickly pay for the fencing by saving of labor, increased fertility of soils and greater production.

It is well known that on southern farms loss of stored grain to rats, weevil and the inroads of weather is a large economic factor. Some reliable estimates place it at as much as 20 to 25 per cent. With corn at 75c such a loss is 15c per bu in one year. But this amount will build a container that will prevent practically all such annual losses for many years. Certainly then a container that permits even a part of such losses is an unnecessary liability.

It is generally conceded that expenditures made to protect livestock from cold in southern states are largely a loss of money, except in the case of caring for the young. This is particularly true with respect to animals being fattened for meat production. The digestion of the necessary food required for that purpose develops ample bodily heat to resist any reasonably low temperatures. However, shelter from cold rain, sleet and serious drafts together with dry surfaces for feed and exercise lots are worth considerable outlay. Yet how frequently do you observe an expensively constructed barn forming an island in a sea of mud. A part of the barn expenditure used in paving the lots or improving the drainage around it probably would be a sound investment.

Another underbuilt feature of livestock structures is water supply. Milk is well toward 90 per cent water, eggs approximately 70 per cent, and meats well over half. Thus it is evident that water is essential to the quantity production of these items as well as being one of the lowest cost ingredients. An ample supply of fresh clean water made available at all times can be a large factor in turning a structures liability into an asset. This has been shown repeatedly by actual experimental work. But even so, far too many farmers depend on their livestock finding drinking water in some swampy pond or inconveniently located creek.

As you doubtless have noted this is not a thesis on farm building construction. I have tried to indicate that there is a lot more to designing efficient farm structures than just selecting and assembling materials. That is a comparatively simple matter if the designer knows definitely just what purpose the completed structure is to serve. To determine this requires the assembly and correlation of data from many sources, frequently not available to the designer.

The animal husbandman, the horticulturist, the agronomist, the specialists in land use, farm machinery, rural electrification and in many other lines, in the final analysis must consider structures as one of their important tools in developing greater and more efficient farm production. They may not be trained in selecting and assembling materials but each can furnish the structures specialist with data as to what specific functions the structures should perform in any particular case. With the information at hand from these several sources and correlated with reference to the importance of each in the farm operations, the solution of the farm service structures problem is not far distant.

Sweet Potato Dehydration

(Continued from page 214)

The feed by-product from sweet potato alcohol distillation compares with corn and wheat as shown in Table 4.

TABLE 4. STILLAGE (Dried Basis Per Cent)

	Solids	Protein	Fats
L 4-5	3.9	16.43	4.85
Corn and wheat	6.0	35.00	6.00

The dehydration of sweet potatoes for food in the United States can be traced back to an initial five-pound shipment from Warriner Starch Company, St. Francisville, Louisiana, to the U. S. Army quartermaster corps at the end of February, 1941. The Army quartermasters asked for a 2,000-lb shipment to be sent to Fort Benning, Georgia, as soon as possible. The following season orders were placed in Louisiana for 2,000,000 lb, last year 4,500,000 lb, this year 7,000,000 lb, and we are being asked to produce 8,000,000 lb for next year. The total quartermaster and lend-lease requirements for this coming season will be approximately 20,000,000 lb. On March 15, 1944, the dehydrators in Louisiana had produced 5,600,000 dried pounds from 738,000 bu of the past season's crop. In dehydration for food the ratio between raw products and finished product varies from 4½ to 1 to 7 to 1. With No. 1 potatoes in good condition, ratios as low as 4½ to 1 have been obtained. Using No. 1's, 2's, and jumbos, there is a larger loss in peeling. Peeling is accomplished by the hand, abrasive, steam, or lye methods. Flame peeling was tried but did not prove satisfactory. The potatoes are next sliced, shredded (Julienne cut) or diced. The larger per cent are now diced as this gives a good dried product, allows a greater drying surface, and the diced product packs into the vaporproof containers better than slices or *(Continued on page 219)*

Agricultural Engineers in Malaria Research and Control

By Fred W. Knipe

MALARIA is one of the most widespread of the diseases with which the human race is afflicted. Perhaps more suffering may be attributed to this disease than to any other with which man has to contend. An instance of its depredations is its present status in India where estimates indicate more than one hundred million cases a year, of which number about one million are fatal.

In the southeastern section of the United States epidemics have been numerous, occurring notably of late years in 1918, 1923, 1928, and 1934. Malaria is endemic throughout much of this area at all times. Concern has often been expressed with regard to a new epidemic which for the past two years has been predicted as probable but which fortunately has failed to materialize.

Malaria extends over a far-reaching territory; in fact, our armed forces are operating in malarious areas. Troops in many of these areas, according to published and presumably authentic records, are being incapacitated in far greater numbers by malaria than by enemy bullets. In fact, it is entirely possible that adequate malaria control will play a most important part in winning the war. The warring nations which control malaria effectively will have distinct advantages from the point of view of troops fit for active combat. Because of this possibility, more attention is being given to malaria and to its control than ever before. It is believed this interest will continue long after the war is over.

Malaria as a disease affecting mankind must be diagnosed in man by the doctor. His method of diagnosis is by measuring spleen enlargements, if an index is desired for a population in a suspected malarious area, or by positive identification of the parasite in the human blood stream in individual cases. In any attempt to control malaria, it is obviously the duty of the doctor to establish the existence of the disease and to prescribe proper treatment.

Malaria is transmitted by a mosquito of the genus *Anopheles;* and in nature it is not known to be transmitted by any other means. This genus of mosquitoes is divided into innumerable species, all of which are believed capable of transmitting the disease. Fortunately, however, only a limited number do act as carriers. For instance, there are eight species of anopheline mosquitoes in the southeastern United States. Only one, *Anopheles quadrimaculatus,* is an active transmitter of malaria. Probably the most significant reason why all anophelines are not malaria vectors is because many of them never feed on man. They prefer to secure their blood meals from animals. Others are indiscriminate in their habits, biting man or animals with little preference. These transmit malaria more or less widely, depending upon the degree of their preference for human blood. Still others prefer to feed on man, and these are the heaviest transmitters.

The female mosquito only, is capable of transmitting malaria. Let us momentarily follow her life history in order that we may understand how this transmission takes place. As an egg, she probably lies in water for from 24 to 48 hours. Then the egg hatches and becomes a larva, the wiggletail known to everyone. The wiggletail develops over a period of from 7 to 14 days, depending upon temperature and environment, turning into a pupa at the end of the larval cycle.

After a brief period, usually of about 24 hours duration, the adult female mosquito emerges from the pupa, rests for a time while her wings dry, and then seeks refuge, usually in a dark quiet spot. Since she is a night prowler, she usually remains in seclusion until dusk, or until after nightfall. Then she sallies forth, looking for a mate rather than for food, although she may take a blood meal before she finds the mate.

After copulation has taken place she must have a blood meal in order that her developing ova may mature. After that blood meal has been taken she usually rests until such time as the urge to deposit her eggs becomes sufficiently strong. She then hunts water in which to lay the eggs. Having found that water, and having oviposited, the cycle from egg through larval and pupa stages to adult and back to the egg is completed. The type of water the mosquito chooses for the deposit of her eggs frequently depends upon her particular species, an important point in malaria control. Rarely will an anopheline mosquito oviposit in water polluted with sewage.

At the time the female partakes of her first blood meal, she cannot transmit malaria. Nor can she become infective with human malaria from a blood meal taken from an animal. In order to become infective, she must bite a human who already is infected with malaria.

As the mosquito partakes of a blood meal from an infected human, she becomes engorged with blood and with whatever may be carried in that blood. In case malaria plasmodia are present in the human blood stream, she ingests some of those plasmodia. Then, within her own body, a transition and multiplication take place in the parasites she has ingested. The parasites develop through certain stages, spread through the body of the host, and finally come to rest in the salivary glands. This phase of the parasitic cycle usually requires from 7 to 10 days. During this time ova have developed within the mosquito and perhaps she has oviposited. If this part of the cycle has been completed, she once more hunts a mate, copulation takes place, and she again seeks a blood meal.

Assume that she now bites another human. At the time she stabs her proboscis through the skin of this person and into the blood stream, she discharges saliva which prevents the blood from coagulating at the puncture point, making it easier for her to obtain the blood meal.

It has been pointed out that malaria parasites have already become lodged in the salivary glands of the mosquito. Since this is true, some of these parasites are discharged into the human blood stream with the ejected saliva. The person bitten has now become infected with malaria, but the clinical manifestations of the disease will not appear for from 7 to 10 days or even longer. When they do appear, the person suffers from severe chills and fever at recurring intervals during the acute stages of the disease. After the acute stages have been passed he may have relapses at intervals, even though no reinfection occurs. These relapses may occur over a period of months or even years; and during such periods, no matter how long after the initial onslaught of the disease, he is capable of transmitting the infection to a mosquito.

Briefly, these are the stages in humans and in the mosquito through which the cycle of malaria must pass. The persons primarily interested in these stages and in the life habits of the female mosquito herself are the parasitologist, the entomologist, and the malariologist. But pause might be made here to inquire, What is the specific interest of the agricultural engineer in a human illness transmitted by a mosquito? That question deserves a specific answer which I shall try to give.

Bear in mind that the mosquito must have water in order to complete her life cycle. This water occurs in the rural areas of the world as rivers and streams; as lakes, which may be natural or artificial; as swamps and potholes; as irrigation water; as wells; in fact, as almost any type of water with which an agricultural engineer may be concerned.

The agricultural engineer is interested in water from the point of view of economic use of that water, and such use is frequently a problem of rural areas, areas where malaria may be most prevalent. A few personal experiences may illustrate the point.

Along the Struma River, in southwestern Bulgaria, is an area so malarious that during the first World War the British and French armies entrenched there faced the German army for more than two years, and at no time could either side muster sufficient fit troops to give battle, because of the high incidence of malaria among the men. In this area are thousands of acres of swamps, often rich first river bottom land. Since this land is wet and unsuited for producing the general crops of the area—tobacco, wheat, cotton, corn, and poppies — it has little value. Reclamation is rarely carried out, chiefly because of the low economic status of

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the people. And that low economic status is in part due to the prevalence of malaria.

I recall that it was a part of my duty to drain a plot of approximately one thousand acres in the area as a malaria control measure. Drainage of this plot, together with other drainage activities in the area, practically eliminated the disease from a number of villages and towns. The economic life because of malaria control alone rapidly improved. Streets in one town were paved; rubble, litter, and debris were removed; houses were repaired; and one merchant informed me that people began paying their store bills because they had money with which to pay them — money earned because they were not sick with malaria. It is interesting to note what happened to the thousand acres reclaimed by drainage. After reclamation one of the best corn crops I have ever seen was produced on parts of it. The value of the land actually increased a hundredfold.

The original purpose had been to drain the land in order to eliminate breeding places of the malaria-carrying mosquito. This objective once attained would have been well worth while in itself. But by achieving it the entire economic life of the community was placed on a higher plane. Increased land values alone accounted for economic returns greater than the original cost of reclamation. This was strictly an agricultural engineering project.

Bear in mind, however, that farm drainage and malaria drainage are not one and the same. Fortunately, though, farm drainage is adequate malaria drainage, for the reason that in farm drainage an effort is made to remove surplus surface water in a reasonably short time; in malaria drainage, surplus water may remain on the surface for a longer time.

Another illustration in point was an experience in India. As you know, there are more areas under irrigation in India, more irrigation structures, more miles of irrigation canals than in any other one country in the world. A problem of malaria control existed in one area in South India, which involved the possibilities of intermittent irrigation of rice. Rice is a crop which requires volumes of water to bring it to maturity, and that water has an economic value. The same water may also be a potential malaria hazard. Since water has an economic value, it seems strange that so little research has been carried on regarding its relationship with rice. But in this instance in South India, it was believed that water manipulation by intermittent irrigation of the rice crop would solve the mosquito problem.

INTEGRATION AND COORDINATION ESSENTIAL

To establish and operate intermittent irrigation on a canal system which had been designed for continuous irrigation was an agricultural engineering problem. But the problem was even more involved than that embraced in a change-over in type of irrigation. Before such a change could be made, proof had to be given to officials of the irrigation system, to government officials, and to the farmers or ryots whose crops were involved, that intermittent irrigation was not harmful to either yield or quality of the rice crop. The agricultural engineer is technically trained to establish and to carry on the necessary routines involved in such research work as is required to obtain proof of this kind. Knowledge of soils, knowledge concerning propagation, growth, and harvesting of grains, and knowledge of the manipulation of the water involved, are all part of an integrated and coordinated system of engineering in agriculture in which malaria control may be in reality the first objective.

Apparently the quality and yield of the type of rice grown in the region of India in question were in no way impaired by intermittent irrigation. Experiments in which this was demonstrated extended over a period of 4 years.

After 2 years of preliminary plot experiments, trials were made for another 2 years from a practical field test point of view. The field tests gave quality and yield results comparable to those from the experimental plots. The result of the experiment was an excellent malaria control, due directly to intermittent irrigation and the attending brief drying of all mosquito breeding places in the area. During the drying period all mosquito larvae were killed.

Another example may be cited in Mississippi where the idea of your own Lewis A. Jones, chief of the division of drainage, Soil Conservation Service, U. S. Department of Agriculture, combined with ideas of Major Nelson H. Rector, who was then sanitary engineer for the state of Mississippi, resulted in both drainage and mosquito eradication. In the Middle West, I believe, Mr. Jones planned and executed some rather extensive flat-sloped ditch banks which were sodded and fenced in for pasture. The runoff from these ditches was slow and sluggish, frequently affording an ideal *A. quadrimaculatus* breeding area.. In order to relieve a similar situation in Mississippi, Major Rector added a cuneate drain which speeded up runoff and eliminated the breeding hazard.

These are only three instances to which I could refer. But they are instances intimately tied up with agricultural engineering. Briefly then, malaria control, when destruction of the aquatic forms of the mosquito are considered, revolves around manipulation of water — usually rural water. Drainage and irrigation are only two engineering factors involved. Other factors include proper location and protection of rural water supplies, proper fluctuation of marginal edges of impounded waters to keep down vegetative growth as practiced by the Tennessee Valley Authority, salinification of seaside lagoons, speeding up or slowing down of velocities of water in stream beds, design and construction of dams across rural streams, and design of automatic siphons for stream flushing.

The foregoing comments relate exclusively to the elimination of conditions favorable to mosquito breeding. Mention, however, must be made of the spreading of oils and Paris green on water in order to control larval breeding. These are old and tried methods wherein use of spraying equipment is involved. The type of spraying equipment used for these operations is almost identical with that employed in agriculture. Much could be said about design and construction of such equipment, all of which is a problem in agricultural engineering. My only remark on this subject is that I hope some agricultural engineer may design spraying equipment which is even more suitable to the purpose than any now on the market.

FARM STRUCTURES PHASE OF MALARIA CONTROL

Mosquito larvae have for a long time been the most vulnerable point for attack in malaria control. The adult mosquito has not been so vulnerable. It is of course true that screening of houses has been advocated and practiced for a long time in an effort to exclude undesirable insect pests, including adult mosquitoes. This practice is usually referred to today in malarious areas as "mosquitoproofing". Again referring to malaria as a rural disease, who, may I inquire, is better qualified to design "mosquitoproof" rural living quarters than the agricultural engineer who specializes in rural structures? He should plan his rural home designs so that windows can be easily screened, and so that mosquitoes cannot gain access to the home through odd places such as cracks in walls and floors, or through chimneys. (Screen doors must be of adequate construction and always designed to swing outward.) This is a part the farm structures engineer can play in malaria control.

Once, in India, I was delegated to plan a typical Indian village dwelling which was to be mosquito proof and still not cost more than a similar but non-proofed house. I designed the house and a unit was built but it lacked one feature — there was no verandah. Now, in South India, the men sleep on the verandah. However, had I attempted to include a screened verandah, the screening alone would have cost more than twice the cost of the entire house.

At this point it would be quite fair for you to ask concerning the construction cost of the type of house in question. My reply would have to be that I was limited to a cost of twenty rupees, amounting in United States money to about $7.00. Not much field in rural buildings design in India, you may say. But, there is a field for such planning in the United States of America and in many other countries.

Very recently a new approach has been opened in malaria control, this time through a positive attack on the infective mosquito herself. This attack is made by means of insecticidal sprays or aerosols. Sprays have been in common use in agriculture for a long time, but their use within human habitations is comparatively new and has been increasing rapidly since 1930. Probably every man in this audience has an insecticidal spray gun in his home which he or his wife uses against insects, especially against the mosquito which breaks into a well-deserved night's rest. If you live in a malarious section of the country, and if you have sprayed and killed a mosquito, it is entirely possible that you not only slept peacefully for the remainder of the night, but also that you prevented a case of malaria in yourself or in some member of your family. This method of malaria control has been going on in the

southeastern section of the United States practically unrecognized until recently. It may account for the present low endemicity to be found there and for the absence of an epidemic in recent years.

It was my privilege to carry on research along this line of malaria control in India for 4 years, terminating in 1942. My colleague, Col. Paul F. Russell, and I found that we could stop malaria transmission in a highly infected area by prudent and systematic use of insecticides. We were able to wipe out malaria within 3 years in villages where the incidence of this disease had been as high as 80 per cent.

Our research was carried on from a very meager preliminary knowledge of the use of insecticides against mosquitoes. We developed methods for extracting pyrethrum from native grown flowers, and we designed and built our own spraying equipment out in the jungle 60 miles from the nearest European and 250 miles from the nearest first-class machine shop.

Here again it is my contention that this is work in the agricultural engineering field. You design equipment for use against agricultural pests — more equipment than is used against any other type of insect pest. You are intimately familiar with the characteristics of good sprays and good spraying equipment. It is but a short step to the design of equipment to be used against mosquitoes.

Recently it was my privilege to visit a certain United States entomological and plant quarantine station where great strides are being made in developing and testing new and better insecticidal sprays. I was surprised to learn that one of their urgent needs is a better type of hand spray than can be found on the market. Their efforts, though largely war efforts at the moment, are being handicapped because they do not have available adequate hand sprayers equipped with really good spray nozzles with which to carry on diversified experiments. Some agricultural engineer is missing a good opportunity when he fails to design just such a spray outfit.

OPPORTUNITIES IN MALARIA RESEARCH AND CONTROL

I have briefly touched upon some of the applications of agricultural engineering principles which I have encountered in malaria control. There are many more. In fact, I cannot help but believe, and many of my colleagues working in malaria control who are members of the medical profession believe with me, that the training of the agricultural engineer is the ideal training for the malaria engineer.

There are opportunities, too, in malaria research, as well as in control. The very nature of the mosquito (its individual habits within a single species) is an interesting study because control of that mosquito from an engineering point of view may depend upon some peculiar habit it may have. An instance of this is the experience of a field man who had been working in a locality where the malaria vector was a mosquito which could not tolerate sunlight and where, consequently, all shade over the water had been removed in order to deprive the mosquito of breeding places. This man was subsequently transferred to a new locality where entomological data were not available. However, he again removed the vegetation shading the water, and within a short time his area was intensely infested with mosquitoes. Later, investigations indicated that the malaria mosquito of that area was of a different species— one which preferred sunlight. In this case dense shading of the breeding area was indicated. Such incidents may be multiplied many times in malaria control.

The present war has dramatically called attention to the world-wide malaria menace. As a consequence, certain preliminary steps are already under way to bring about world-wide control. The National Malaria Society recently met in Cincinnati, and at that meeting proposals were made with a view toward eliminating the disease from this country.

But before control can be permanently accomplished, much additional research may be necessary. After fundamental research has established the pertinent facts, control measures must be instituted; and after control has been achieved, it must be maintained. The field for malaria control is world wide, and the opportunities in control will probably be just as wide.

If, and when, these proposals are put into practice, much of the southeastern section of the United States, the section you represent, will be involved. Therefore you, as individual agricultural engineers, and your Section of the American Society of Agricultural Engineers could and should play a prominent part in advocating and in carrying out the control measures. You are interested in practically every phase of mosquito elimination for malaria control even though you may not have realized your interest. You are interested in contour farming, in drainage, in water supplies, in river and stream training, and in power developments. These are all forms of water manipulation. You are interested in better rural homes. This involves mosquitoproofing. You are interested in destruction of farm insect pests, among which may rightly be included the malaria-carrying mosquito. This practice requires sprays and spraying equipment, a natural field for development by the agricultural engineer. You are interested in the preservation of wild life — birds and animals. Upon investigation you will discover that adequate mosquito control measures frequently involve practices which stimulate wild life growth. This point has been clearly demonstrated by the Tennessee Valley Authority.

In conclusion, therefore, may I leave with you the following suggestion: Since the agricultural engineer is equipped, by training and experience, with the knowledge underlying practically all engineering practices used in malaria research and control, it would seem logical that he should assume a leading role in further engineering research having as its ultimate objective the control and final elimination of this disease which for so long has exacted so much suffering and such a heavy economic toll from mankind.

Sweet Potato Dehydration

(Continued from page 216)

Julienne cuts. A larger weight per unit of volume is obtained with the diced product without compressing, which saves some on shipping space.

No extensive discussion of food dehydrators will be attempted in this paper as there are several types in use, each with definite operating characteristics.

The largest capacity plant in Louisiana uses four tunnels. The potatoes are spread on trays, 1½ lb of raw potato per square foot, and the trays are stacked on low wheel trucks which are steamed for 4 to 6 min in a steam chamber to stop enzyme action, and then pushed into the tunnel.

The air flows through the tunnel in a direction counter current to that of the movement of the trucks. The driest potatoes are exposed to the hottest gasses, which are 165 F. The potatoes stay in the tunnel from 6 to 8 hr depending upon the moisture content of the raw potatoes and the temperature and humidity of the outside air, and they are dried down to 5 or 6 per cent so as to be under the Army requirement of 7 per cent or less.

A second dehydrator uses a counter-current drier of two tunnels, removes the potatoes from the tunnels when they have reached 10 or 12 per cent in approximately 5 hr, and finishes dehydrating in bins through which dessicated air of 110 F is passed. This gives a greater capacity to the tunnels.

A third drier of four tunnels uses counter current on the first stage of drying and parallel current on the second stage.

A fourth dehydrator uses two conveyor aprons. The steamed potatoes are spread on the first conveyor where they remain a relatively short time and are then dumped on to the second conveyor. These conveyors pass through a heated tunnel with air passing both across and through the mat of drying potatoes.

A fifth dehydrator employs three conveyor apron driers with numerous small gas-fired furnaces equally spaced on one side of each drier.

A sixth dehydrator employs three short conveyor apron driers handling a limited amount of sweet potatoes as most of their drying is on other crops.

From all reports the sweet potato will stay on the market in the dehydrated food form after the war and the expansion of the sweet potato in feed, starch, and alcohol is just beginning.

At the present time there are nine feed dehydrators and thirteen food dehydrators in operation in Louisiana. Not all of these driers are handling sweet potatoes at the present, but they can, and more sweet potatoes will be dried this year than last.

Several interested parties are making plans for feed dehydrators for sweet potatoes and some have progressed to the point of submitting applications to the War Production Board for the necessary materials. With the need for additional feed and the better steel situation, it is hoped that many additional feed dehydrators will be built in the South immediately.

A Rainfall Applicator

By W. D. Ellison and W. H. Pomerene
MEMBER A.S.A.E. ASSOCIATE A.S.A.E.

DURING the summer of 1939, experimental work which would lead to the construction of a rainfall applicator was started at the Coshocton, Ohio, project of the U. S. Soil Conservation Service. Mr. Pomerene, co-author of this paper was assigned to carry on some of this experimental work and to design many of the mechanical details.

The service requirements, as agreed upon at that time, were that the applicator should be suitable for applying rainfall of different drop sizes, drop velocities, and at various intensities. Apparatus was to be constructed in such a way that these rainfall factors could be varied one at a time and studied as independent variables.

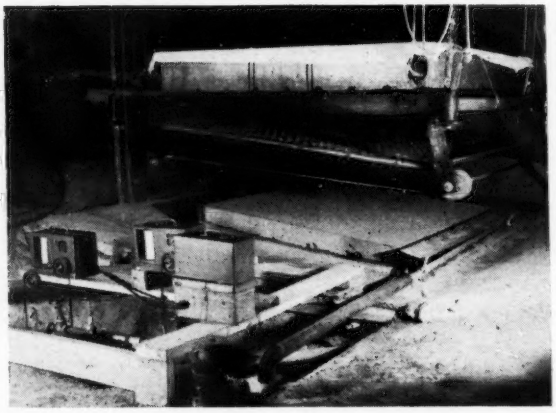


Fig. 1 This shows the rainfall applicator hanging over a 5x6-ft plot. Note the screen indicated as C in Fig. 2 is on a 10 per cent slope parallel to the surface of the plot

Decision on size of applicator was based on plot sizes previously used on the project. Many plots 5x6 ft had been used, and the 6x7-ft size was chosen so that it would overlap by ½ ft the edges of the 5x6-ft plot.

The applicator is shown in Figs. 1, 2, and 3. It consists of a water tank, A; an overflow weir, B, controls the depth of water in the tank; there are holes in the bottom of the tank through which water drips in the first stage of applied rainfall; an interchangeable screen, C, intercepts this water and causes drops of the desired sizes to form on a plane parallel to the soil surface; a motor, D, keeps this screen in motion so that drops will be well scattered over the soil surface; a curtain, E, is drawn across the plot to start or stop the rainfall.

Fig. 1 shows the applicator hanging over the plot ready for operation. The tank is covered with a sheet to keep out dust particles which might interfere with successful operation. Recorders in the left foreground are set over tanks into which the runoff and percolation flow. The ropes and pulleys near each corner of the frame are used for raising and lowering the equipment. The interceptor screen used in starting and stopping rainfall was rolled back at the time this exposure was made.

Tank A, Fig. 2 is made of galvanized iron. The holes in the bottom of the tank were made by drilling ½-in holes on 4-in centers. A brass plate was soldered over each of these, and a hole was drilled in the center of each plate and reamed to 0.042-in diameter.

The screen is made of chicken wire covered with cheese cloth. The cloth is placed loose so that it will depress and sag in each opening of the wire. Raindrops are formed on short lengths of wool yarn which hang from the cheese cloth at the center of each depression. This screen is hung parallel to the surface of the test plot.

The curtain is of oilcloth and is hung in such a way that when it is drawn across under the screen to intercept the rainfall the water is spilled to one side of the plot.

Control of Rainfall Intensity. Rainfall intensity can be varied considerably by increasing or decreasing the depth of water in tank A. This is done by raising or lowering the height of the overflow weir, B. Further decreases in intensity can be obtained by inserting a small copper wire in each hole in the bottom of the tank. Intensities used in experiments at Coshocton varied from 4.8 to 14.8 inches per hour, and greater veriations could be developed. Tests were made to determine regularity of intensity, and it was found not to vary more than about ± 3 per cent from one run to another. Maximum variation in distribution of this precipitation over the plot was found to be about ± 10 per cent.

Control of Raindrop Size. Raindrop size is controlled by screen C. Chicken wire with 1-in openings and small size wool yarn were used to make small drops. Wire with 2-in openings and large size wool yarn were used to make larger drops. Only two drop sizes, 3.5 mm and 5.1 mm, were used in the Coshocton experiments, but other sizes could be developed. Drop sizes were tested and found to vary only about ± 6 per cent.

Control of Raindrop Velocity. Drop velocities are controlled by raising or lowering screen C. In operations at Coshocton it was found most convenient to keep the screen attached to the tank and raise and lower screen and tank together. The velocities which the different sizes of drops will acquire when falling from the different heights can be taken from Law's curves[1].

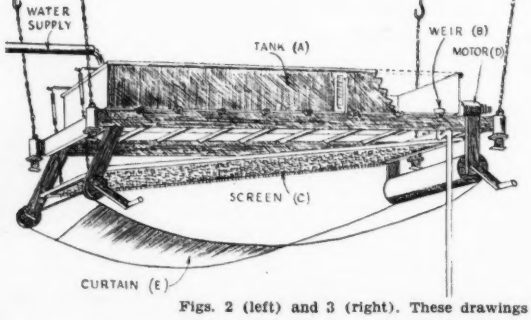
More detailed drawings and specifications can be obtained by writing the U. S. Soil Conservation Service, Coshocton, Ohio.

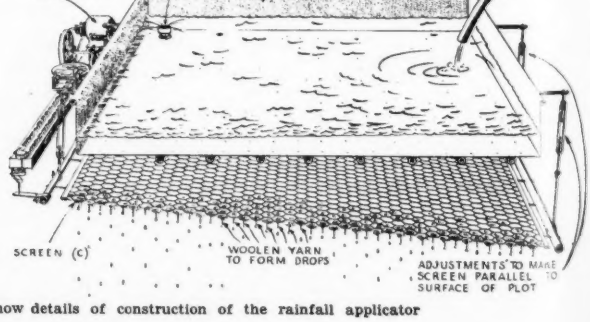
This article was prepared expressly for AGRICULTURAL ENGINEERING.

W. D. ELLISON and W. H. POMERENE are project supervisor and assistant agricultural engineer, respectively, North Appalachian Experimental Watershed, Soil Conservation Service, U. S. Department of Agriculture.

ACKNOWLEDGMENTS: Similar equipment was used by D. A. Parsons and J. O. Laws in 1937. F. A. Post and Don Rader assisted with development. Construction was mostly by C.P.S. Camp 23.

[1]Laws, J. Otis. Recent Studies in Raindrops and Erosion, Agr. Engr., vol., no. 11, November, 1940, pp. 431-433.





Figs. 2 (left) and 3 (right). These drawings show details of construction of the rainfall applicator

How to Determine the Drainability of Soils

By Ralph L. Patty

MEMBER A.S.A.E.

IT IS known that the drainability of soils depends largely upon the size of the particles which go to make up that soil. A drainable soil will contain plenty of the coarser particles found in sand and the coarser particles of silt. The smaller soil particles found in clay and the finer silt retards the movement of gravitational water and a soil containing a high percentage of these particles will have low drainability. It is highly important that the drainage engineer know the composition of the soil with which he works in order to design correctly for the drainage of farm land. It is most important in laying out lateral lines of tile for draining low lands. In the Wisconsin Drift area of the Mississippi Valley the slough bottoms and flat lands need thorough drainage for modern farming methods. This is not only to furnish a good root zone for crops, but also to make it possible to operate farm machines efficiently. The engineer needs to know the degree of drainability of the soil in order to give the lateral tile the proper depth and the lateral lines the proper spacing. He should also know the soil composition in designing open channels against erosion and silting. (This same information is almost of equal importance in irrigation and soil erosion control work.)

The drainability of soils can be obtained accurately and quickly by analyzing soils with the hydrometer. The method has been used by the author in drainage engineering classes since 1934. The early drainage engineers were handicapped in their work in having little if any knowledge of soils. The agricultural engineer of today has the training in soils but is generally obliged to depend upon rough inspection tests of the soil that are not very dependable. Soils men with long experience agree that identification of the composition of a soil by inspection only is very uncertain and we do not believe that such a test is at all adequate for the drainage engineer to depend upon in design work.

The conventional pipette method of laboratory soil analysis is tedious to make and involves considerable laboratory technique. It does not lend itself well to the drainage engineer's use.

The hydrometer method of analysis is accurate and dependable. It requires less painstaking control, is comparatively quick, and lends itself well to the office of the practicing engineer. The analysis requires care and accuracy of course, but does not require a great deal of training in laboratory technique. The method is comparatively new. It was developed in the soils research laboratory of Michigan State College and reported around 1930 by Prof. George J. Bouyoucos. It is now well accepted by soils men over the country and has been adopted by the U. S. Public Roads Administration in their highway research work.

The hydrometer analysis is based upon the principle that solid particles of approximately equal density in suspension in a liquid will settle out with a speed directly proportional to the size of the particles. The coarse particles such as sand will come down quickly while the finer particles will be held in suspension longer and come down more slowly. In this way the sand settles out quickly and is separated from the silt and clay. The silt which is made up of particles larger than clay settles out next and is thus separated from the clay. Lastly the coarser clay particles are separated from the conventional clay in the same way leaving the very fine clay still in suspension. This gives the complete mechanical analysis of the soil, and it can be made in less than three hours time after the soil has been dried to constant weight in the oven. Each of the ingredients, including total sand, conventional silt and conventional clay will be determined in percentage of the soil by weight. These three readings will make up 100 per cent of the soil. However, since the percentage of very fine clay may be important to the problem, its percentage is also obtained, but the very fine clay figures in as a part of the conventional clay in making up the 100 per cent of soil.

Significance of Clay Colloids. As stated above, the very fine silt retards the drainability of soils along with the clay. It will have an effect that is closely related to clay in the behavior of soils. For this reason the analyst in developing the test included the finer silt particles along with the clay and called the combination of the two "soil colloids". We will call them "clay colloids". In making the hydrometer analysis then, the analysts allowed the coarser particles of silt to settle out for 15 min and at the end of that time all soil left in suspension was classified as clay colloids. This is a significant figure in rating a soil for drainability as well as for many other purposes. The percentage of clay colloids indicates the proportion of heavy soil in a sample and can be obtained in 15 min after the soil is placed in suspension. It will give the drainage engineer a surprisingly close drainability rating for the soil. However, the complete analysis of the soil, which gives him the total silt and total clay and also the very fine clay will furnish a further check and assurance for his diagnosis. In the case of a few soils it will possibly modify his rating of the soil to a slight degree. But the clay colloids in the soil will be the most significant figure in rating it drainability.

How Hydrometer Analysis Is Made. Space will not permit complete and detailed instructions for making the analysis as there are several corrections and exceptions and the reasons for them which should be included. Complete instructions may be obtained from the Taylor Instrument Company along with the special hydrometer and graduate used in the analysis. They are probably available from the Michigan State College also. They are given in a little booklet, entitled "A Comparison of the Hydrometer Method and Pipette Method for Making Mechanical Analysis of Soils," by George J. Bouyoucos.

The laboratory equipment and materials needed, in addition to these two pieces, includes an electric dispatch oven, a small metric scale, a soil disperser (similar to a malted milk mixer), a Fahrenheit thermometer, a 5-cc pipette, a mortar and pestle, distilled water, two deflocculating agents, and a horn spoon. A spoon is necessary because soil samples must be dipped rather than poured in handling. Most of this equipment can be identified in Fig. 1. All of this equipment is relatively inexpensive except the dispatch oven and the soil disperser. Any kitchen oven can be used for drying a small number of soil samples to constant weight, and the soil-disperser equipment will cost around $25.00, and can be secured from the Hamilton-Beach Co.

The steps in making the soil analysis are briefly as follows: A representative sample of the soil in the field is taken with a soil auger. It may be "quartered" to a pint-sized sample if carefully done. The sample is placed in the oven and dried to constant weight (8 hr at 220 F should be amply sufficient). A 50-g sample is weighed out and placed in the soil disperser. It is then well covered with distilled water and allowed to soak for

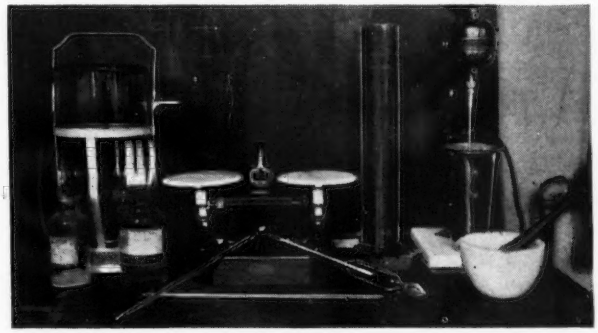


Fig. 1 This shows the laboratory equipment used in making the hydrometer analysis of soils. Equipment of particular interest is the tall graduate at the right of the scale pan and the special hydrometer just in front of it. The electric soil disperser and cup is shown to the right of the graduate. With this equipment the percentage of clay colloids in soil is determined. It is the clay colloids in soil that reduce its drainability

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

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HYDROMETER ANALYSIS OF SOILS FOR RAMMED EARTH: Department of Agricultural Engineering, South Dakota State College Experiment Station—

Date	Soil Sample	Wt. of Sample	Defloc. Agent Used	Stirring Time Min.	Temp. F°	Reading 40 sec.	Corrected	Reading 15 min.	Corrected F°	Reading 1 hour	Corrected F°	Reading 2 hour	Corrected F°	Total Sand Per Cent	Tot. Col. Per Cent Read. 100 Wt. x 1	Conventional Clay Per Cent	Very fine Clay Per Cent	Conventional Silt Per Cent	Analyst	Color, Appearance, Behavior, Coarse Aggregate Remarks
2/13 1935	No. 1	50gm	Na OH $Na_2C_2O_4$	10	78°	36.4	38.6	20.5	78° | 2.2 22.7	18.0	76° | 1.8 19.8	16.1	74° | 1.4 17.5	22.8	45.4	39.6	35.0	37.6	R.L.P.	Heavy grey soil. No noticabe sand No Pebble.
2/15 1935	No. 2	50 "	"	10	72.5°	27.0	28.1	16.4	72.5° | 1.1 17.5	13.0	72° | 1.0 14.0	11.1	72° | 1.0 12.1	43.8	35.0	28.0	24.2	28.2	R.L.P.	Yellow Subsoil. Some small pebbles. Sand slightly evident.
1/29 1933	No. 3	50 "	"	5	71.°	11.0	11.8	9.0	71°-0.8 8.8^{c-1}	7.5	71° 0.8 7.3^{c-1}	6.5	73° | 1.2 6.7	76.4	17.6	14.6	13.4	9.0	R.L.P.	Light grey mottled. Some pebbles. Could use 100 gm. Sample
	Av. S. Dak. Soil													38.7	35.9	28.7	24.5	32.6		Natural Soils From All Parts of S. Dakota - Av.

Fig. 2 A sample data sheet that is used to record the hydrometer analysis of soils. The record of each step in the analysis greatly reduces the possibility of error and simplifies the process for the analyst. A record of three representative soils is shown on the sheet

10 min or more. Two deflocculating agents are added, the disperser is started and the solution is stirred for 10 min when all soil particles will be entirely separated. The solution is carefully washed into the special graduate and distilled water added, bringing the volume up to one liter. Next it is quickly remixed by hand and set on a solid flat table top and the special hydrometer is immersed in it. A stop watch is started simultaneously with the placing of the graduate. The soil particles that are in suspension begin to settle out immediately. At the end of 40 sec the sand particles will have settled and the hydrometer reading quickly taken will give the total grams of soil left in suspension. This will be the total silt and clay. The only use we have for this figure is that it is subtracted from 100 per cent in order to get the per cent of sand that has settled out. Since a 50-g sample was used, the percentage of silt and clay is obtained by multiplying the hydrometer reading over 50 (weight of sample) by 100. The per cent of sand that settled out is obtained by subtracting the answer from 100 per cent.

When the stop watch which has continued to run reads 15 min, the per cent of clay colloids in the soil is obtained. The coarser silt particles have settled out and the finer silt particles and clay remain in suspension. The hydrometer reading again gives the grams of soil in suspension which will be the clay colloids. In order to get the figure in percentage of the soil sample the hydrometer reading is divided by 50 (weight of soil sample) again and the result multiplied by 100 (see heading for column 16, Fig. 2).

At the end of one hour the sand and silt has settled out, leaving the clay in suspension. The percentage of clay is found in the same way as described above. The silt is obtained by adding the per cent of sand and clay and subtracting it from 100.

At the end of two hours the particles left in suspension are classified as very fine clay and the percentage is found as before. This very fine clay was already included in the percentage of total clay or conventional clay as it is called.

All readings of the hydrometer are corrected for temperature of the water as the data sheet shows. All of this may sound complicated, but with a carefully worked out data sheet each step is recorded by the analyst and there is no chance for him to omit any reading nor to make a mistake in the readings that cannot be readily detected and corrected. A second analysis is made of each soil for a check. In order to condense the record only one temperature column is provided. This is for the initial reading. Later temperature readings are recorded in the small square at the left in columns 10, 12 and 14. The correction made for that temperature is at the right. This sheet was worked out at the South Dakota Agricultural Experiment Station for use in analyzing soil samples for earth wall construction. The analysis would be exactly the same for determining the drainability of soils.

To Determine Drainability Rating. In order to diagnose the analysis properly after it is completed will require some experience on the part of the drainage engineer, but with the figures for three soils — an average soil, a very heavy soil, and a very light sandy soil to start with — he could not go far wrong in his diagnosis. In fact, his first diagnosis would be far closer than that made from the inspection method. On the data sheet shown in Fig. 2, soil sample 1 has been selected as an example of a very heavy soil. The drainability of this soil would be very poor. The figures are not fictitious. It is the analysis of a soil taken from the laboratory records and is a well-known soil of extremely low drainability. Soil sample 2 is very close to an average soil and is a soil of average drainability. The percentage of conventional clay and the percentage of clay colloids are especially close to the average soil for South Dakota as a comparison with the figures in line 4 of Fig. 2 shows. Soil sample 3 is a very light sand soil containing 76.4 per cent of sand and only 17.6 per cent of clay colloids. This soil is not the sandiest soil that has been sent in for analysis but it is about as high in sand as will usually pay for complete drainage. It is, of course, very high in drainability.

These samples were taken by members of our own staff and are truly representative. The average analysis of 500 samples of soil sent in to the laboratory from practically all parts of America including Canada and Mexico shows: total sand, 46.6 per cent; conventional clay, 23.4 per cent; conventional silt, 30.0 per cent, and clay colloids, 23.4 per cent. The average of all these soils shows more sand and a lighter soil than the average of the South Dakota soils, but this average would not be representative because in many cases the sender looked for a light soil to send in. However, the correspondence concerning these samples generally indicates whether or not it is representative of the region, and judging from this the average soil from over the United States and Canada is not far from that of South Dakota in mechanical analysis. The average South Dakota soil shown above would not be exactly representative for soils in slough bottoms in the state either. In most sloughs the soil will analyze somewhat heavier due to the silt which has washed in to form the top soil. This layer of silt is not thick enough to affect the drainability of the soil a great deal in this state but in some more rolling sections it would make considerable difference. The figures shown in Fig. 2 should be useful to the drainage engineer in starting the use of the analysis in his work. After analyzing several soils he will not only know whether the soil is within reasonable limits of drainability but will be able to compare its performance accurately with systems formerly installed.

Rating the Drainability. After the test is completed the engineer would first look for the percentage of clay colloids in the sample. If the soil is high in clay colloids it is sure to drain poorly, and if low in clay colloids it is sure to drain well. A look at the total sand content will be a further check on the rating. If the percentage of sand is high the soil will drain well, and a soil high in sand cannot possibly be high in clay colloids. (The total sand in soil samples as obtained by the hydrometer analysis will average approximately 11 per cent more than that retained on a 200-mesh screen as obtained by "floating off" the silt and clay.) Looking at the other figures, if the sand is rather low, then the higher the silt content as compared to clay the better the soil will drain. This is because the particles of silt are larger than the particles of clay.

Opportunity for More Research. The assurance resulting from this soil analysis will be found most gratifying to the engineer in his design work. In the case of most soils his diagnosis will be quite satisfactory and as close as desired for practical purposes. However, there is an opportunity for research in developing a chart for determining the drainability of a soil in minute detail by use of this analysis. Since the particles of soil settle out according to their size, and since they continue to settle out from the beginning to the end of the analysis, a continuous chart of the readings can be made. This would give the complete curve for the particular soil and its density.

Accurately controlled work would show the exact effect this arrangement of particles in the soil will have on its permeability.

Some preliminary work has been done on this, but as yet only enough to find out that such a study requires very accurate control. In developing such a chart the exact drainability of a soil must be checked against the analysis of it. In order to obtain the slightest difference in the drainability of soils natural field conditions of the soil must be duplicated and highly accurate results obtained. The hydrometer method of soil analysis will furnish the accurate soil analysis in a simple and dependable way.

Legislation for Drainage Construction and Maintenance

By Lewis A. Jones
FELLOW A.S.A.E.

DRAINAGE of farm lands in this country began soon after the first settlement was made and the practice has played an important part in the development of American agriculture and in the improvement of public health. It is conservatively estimated that more than 100 million acres of fertile land have been added to the cultivable area in the United States, or have been made more productive and profitable by improvements constructed by drainage projects. A large part of this has been done, and could only be done, through cooperation under laws that confer special authority upon groups of landowners legally organized to obtain drainage. A brief outline of the development of drainage legislation will indicate the necessity for and the objectives of such laws.

The first drainage work, other than that limited to individual farms, was confined to small groups of landowners who found it necessary to cooperate in providing a common outlet for their farms before it was possible to dispose of the drainage waters. It was discovered early in the work that even where only a few landowners were involved there was frequently one or two who refused to cooperate, and the rest of the landowners had to pay for all the work or go without the improvement. When many landowners were involved it was practically impossible to arrange cooperation. This difficulty brought about the passage of laws which provided authority for constructing necessary drains, where the majority of the landowners desired such improvements, and requiring all landowners whose lands were benfited to pay their share of the cost. The first drainage laws were passed about 200 years ago. Under these early laws the drainage improvements constructed were small and frequently the work was done by the farmers themselves. In all cases the work was paid for in cash, as the laws made no provision for incurring debts but simply provided methods for assessing benefits and forcing those benefited to pay a proportionate share of the cost.

In the development of the midwestern part of the country it was found that large areas of the flat prairie land could not be successfully cultivated until large outlet ditches had been constructed. Expensive machinery was required to do this work economically, and it became necessary to employ contractors who were properly equipped. As the landowners could not raise at once the comparatively large sums of money required to pay the contractor when he had completed his work, for a time drainage development awaited legislation that would provide a practicable method of financing.

In 1879 Illinois passed its levee and farm drainage acts which permitted the districts to issue bonds that might be sold to obtain the cash with which to pay for the construction. These bonds were made a first lien on all assessed land within the district, in order that they would be attractive to investors, and were made to mature serially so that the landowners would have a period of years in which to pay the assessments and redeem the bonds. This arrangement enabled the owners to make part of the payment from income from the improved land. Since 1879 practically all of the states except some in the northeastern portion of the country have passed laws which have been approved by the courts, by which drainage districts can be established and financed under the supervision of the courts.

During the past one hundred years there have been literally thousands of decisions rendered by the courts that have affected the procedures involved in establishing and operating drainage enterprises. Laws have been amended again and again until, in several of our states, it requires a lawyer well experienced in drainage matters to determine just what is necessary to meet the legal requirements.

According to the census of 1940, there are 81,000,000 acres in enterprises organized under state drainage laws, not including undertakings by the state itself amounting to 620,000 acres. The laws have been enacted for the purpose of giving landowners desiring to improve their wet lands for agriculture (1) a means of effective cooperation in obtaining the drainage work necessary, (2) a method of equitably apportioning the cost among the owners to be benefited, (3) the right to levy and collect taxes that will require the participation of all who are to receive benefits, (4) the right of condemnation against private property required for public use, and (5) a means of distributing the cost over a considerable period of years.

Each drainage enterprise is legally established only after the filing of a petition therefor signed by one or more landowners who will be benefited by the enterprise. Each law states specifically the minimum number of petitioners, or the minimum portion of all owners in the proposed enterprise, and many laws require also that the petitioners own a definite portion of all the land included. Some laws restrict the petitioners to resident owners, or to adult owners. Some laws authorize certain state or other government officials to make the petition for establishment. The petition must indicate in some prescribed manner the location and approximate extent of the proposed enterprise. Some states require a list of the landowners and their acreages to be affected.

The petition is filed with the county board or some court having jurisdiction in the county, or in one of the counties in which the enterprise is located. The requirement may be different under different laws of the same state. The board or court makes investigation as to the sufficiency of the petition, and such further investigation as the particular law requires as to the desirability of the proposed work, and then establishes the enterprise or dismisses the petition. Most of the laws provide that the petitioners shall pay the cost if the enterprise is not established, and many require that a bond for that purpose be filed with the petition.

Before order of establishment is issued public hearing on the petition is held. Notice of the hearing is given to the landowners, either by personal service, by posted notice, or by publication in some newspaper, as prescribed by the particular statute. In accordance with the information developed at the hearing or hearings, the area to be included and the plan of drainage works to be constructed, the enterprise is established or the proceedings are dismissed. Under some laws the determination is made in the discretion of the court or board; under other laws establishment or dismissal is in accordance with the will of the landowners expressed by an election.

The amount of information that must be developed before a drainage enterprise is established varies greatly among the states. In Iowa the county supervisors have an engineering survey made and adopt a tentative plan of improvement works before holding the hearing on the petition. This procedure gives the landowners a concrete proposition to discuss, showing the lands that will be assessed, the location of the drains, and the estimated cost of the undertaking. Only after these facts have been considered, and amendments made as appear advantageous, are the petitioners relieved of responsibility for the expense incurred. In Arkansas, on the other hand, where only three landowners are required to sign the petition for a drainage district, establishment is mandatory if such three or more petitioners own a majority of the acreage to be included. However, establishment is mandatory also if the signers of the petition are merely a majority in number of the landowners, regardless of the size or value of their holdings; or if their holdings comprise a majority in value of the real property in the district. Thus a few owners of a large area of unimproved land could involve a large number of non-consenting owners of high-value land; and a majority of small ownerships might organize a district comprised largely of the property of a few objecting owners. Apparently those who framed this law were so desirous of encouraging the organization of drainage districts that prevention of possible injustice to objectors was overlooked, at least in part.

When the order of establishment is issued, management of the enterprise passes to the officials or board legally designated, to obtain construction of the drainage works and arrange payment.

This paper was presented at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1943, as a contribution of the Soil and Water Division.

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There are two major forms of organization provided by different statutes. Sometimes both are available in the same state. In one, which may be called the county form, management of the affairs of the enterprise, after it is legally established, is in the hands of the county board or some official or board that administers all drainage enterprises in the county organized under that law. In the other, which may be called the corporate form, management is in the hands of a board elected by the landowners who will bear the expense of the drainage, or appointed for that particular district by the authority that issues the decree of establishment. According to the report of the 1940 census of drainage, 57 per cent of the 81,000,000 acres in public drainage enterprises is organized in the county form, although 24 of the 38 states included in the census provide only the district form and another 4 states provide both. Management by township officials is authorized in some states, for small districts.

Both forms of organization operate effectively when well administered, and the author would hesitate to suggest that a change be made in any of the states where numerous districts have been organized and a long line of court decisions has been rendered on drainage activities.

At various times during the past 30 years considerable interest has been shown in writing a uniform drainage law that could be adopted without change by all states. Attention is called to the fact that such a law is impractical due primarily to differences in state constitutions relating to tax limits, levying of special assessments, serving of notices, etc. It is possible, however, to outline a general method of procedure in organizing drainage enterprises that can be followed in the law for each state, making necessary adjustments in each state to fit the provisions of the state constitution.

GENERAL METHOD OF ORGANIZING PROCEDURE NEEDED

Such an outline of procedure was prepared many years ago by Mr. Jacob A. Harmon, consulting engineer of Peoria, Illinois, and published in the "Engineering News-Record" of April 27, 1922. A study of this outline will reveal features that tend to simplify the operation of districts organized under existing laws in many states.

In addition to the procedures outlined by Mr. Harmon, it is felt that definite provision should be included in a drainage law for the filing of certified copies of all plans, profiles, assessment rolls, etc., with some central state agency where they will be held as a permanent record. Most drainage laws now require that such records be filed with the county records or township records, but past experience shows that attorneys and engineers frequently take the file copies from the court house and fail to return them. A recent study of the drainage districts in one of the states disclosed the fact that records of only 15 per cent of the districts were on file in the county court houses as required by law. This means that any plans for rehabilitation or maintenance of the drainage improvements must be based on new surveys. In the state in question, in planning for the rehabilitation of the drainage improvements it was necessary to spend thousands of dollars on surveys that would have been unnecessary had the original plans and profiles been available. Where new tax levies must be made, in accordance with the original assessment, and that assessment roll has been lost, there is opportunity for almost endless litigation and delay in making a reassessment and having it confirmed.

All drainage acts should include definite provisions authorizing the district officials to carry on maintenance work and specifying how the cost of such work is to be assessed against the landowners, and how collected after they are assessed. Provision should also be included for dissolving a district if developments indicate that such a step is desirable.

In most states existing drainage laws provide for a continuing organization and grant authority to the district officials to maintain the drainage works, and to levy maintenance assessments therefor, without the necessity of landowners filing petitions and incurring court expenses that delay and increase the cost of such work. In such states failure to maintain drainage improvements is caused primarily by failure of the district officials and landowners to realize the importance of maintenance work. The only practical way of overcoming the difficulty is a campaign of education that will convince the district officials and the landowners of the vital importance of such work, if the district is to continue to operate as a successful enterprise.

In other states maintenance is delegated by law to county officials or appointees of such officials who are not personally interested in the affairs of the district. Typical of this group is Indiana where the county engineer, who holds an elective office is given the responsibility of maintaining drainage works in addition to his other duties. He is authorized under the law to determine the maintenance work to be done and to allot the work to the various landowners in accordance with benefits received. If the landowners fail to perform the work allotted to them in a reasonable time, the engineer has authority to let the work by contract and assess the cost against the land to be collected as taxes. This would seem to be an effective and efficient method of providing for maintenance, but experience has shown that most of the county engineers consider drainage a minor part of their responsibilities, and are not inclined to carry out maintenance work that will result in special taxes being levied against constituents whose votes are necessary to retain them in office.

It is my opinion that in states where the corporate form of drainage organization exists there is some advantage in having two laws — one suitable for handling small projects where the cost of the work is small and can be paid for in cash, and one following the general procedure outlined by Mr. Harmon, i.e., providing the financing of the work by the issuing of bonds and giving the landowners a period of years in which to make payment. In some states, where the drainage works were mostly constructed many years ago and it is difficult to get maintenance work done because that requires practically reorganizing the district, it is believed that a law following the law suitable for small projects would prove advantageous. Districts organized under such law would have a continuing board of managers or district commissioners personally interested in the project and authorized to maintain the drainage improvements and levy taxes to cover the cost of that work without incurring any legal expenses or encountering the delays necessary for filing petitions, holding hearings, etc.

A DRAINAGE LAW ADAPTED TO SMALL DISTRICTS

Ray W. Carpenter, state drainage engineer for Maryland, and head of the agricultural engineering department of the University of Maryland, is responsible for the general assembly of Maryland passing a drainage law in 1941 that is excellent for handling small districts where the required work can be paid for in cash. This law gives the board of county commissioners jurisdiction in the establishment of public drainage associations, and provides a simple and direct procedure that keeps costs of organization at a minimum and sets up a board of managers of landowners in the district to direct the affairs of the district and maintain the improvements. It is suggested that anyone interested in drafting a law suitable for small enterprises secure a copy of this law (Chapter 261, Acts of 1941, State of Maryland). It should be remembered, however, that the provisions of the Maryland law are drawn to fit the constitution of that state and it may be necessary to make changes to meet constitutional requirements of other states.

There are many instances where areas of land that should be drained as a unit are located in two or more states. A few of the drainage laws authorize the districts to cooperate with districts of adjacent states, but as a rule there are no satisfactory arrangements for meeting such a situation. It is believed that a federal drainage law authorizing the organization of such areas into drainage enterprises under the jurisdiction of the federal courts would provide for such cases. That law should follow the general procedure outlined by state laws, except that the petition should be filed with a federal court and all proceedings be held in that court. Provision could be made to have the law become effective in any state upon approval by the state legislature and the enactment of the necessary state law to make it effective.

During the past 35 or 40 years the federal government has followed the policy of assisting irrigation projects in the western states in constructing their improvements. At the present time the policy is for the government to pay the cost of constructing the irrigation improvements with an agreement that the cost will be repaid to the government without interest over a period of years. Identical bills have been introduced in both houses of the present session of Congress making provision for similar assistance to drainage enterprises. The bills are HR.3069 and S.1289. It is believed that if such assistance is desirable and *(Continued on page 236)*

A. S. A. E. War Service Honor Roll

LISTED here are the names of those members of the American Society of Agricultural Engineers who are, or have been, on active duty with the various war services of the United States and its United Nations allies, according to the records at A.S.A.E. headquarters. This list is kept complete and up to date in so far as possible, and the Society will welcome information from its members — and members of their families — covering (1) additions to the list, (2) promotions in rank, (3) changes or corrections as to branch of service, (4) discharges from services, etc. Such information should be reported promptly to the Secretary, A.S.A.E., St. Joseph, Michigan.

M. S. Adams, Maj., 2-D 5th Defense Battalion, USA
W. M. Adams, Lt., Air Force, USA
A. E. Adkins, A/C., USA
C. O. Anderson, Lt., Corps of Engineers, USA
D. A. Anderson, Capt., Ordnance Dept., USA
J. M. Anderson, 1st Lt., Field Artillery, USA
S. G. Anderson, A/S, USNR
Q. C. Ayres, Commdr., Hdqr. 13th Naval District, USN
J. M. Babb, Lt., Quartermaster Corps, USA
T. L. Baggette, Maj., Field Artillery, USA (Honorable discharge)
R. W. Baird, Maj., 605th Coast Artillery, USA
H. R. Ball, Lt., (jg) Parachute Officer, USNR
V. J. Barlow, 1st Lt., USA
J. Baso-Fontaneil, Pvt., Air Force, USA
J. E. Beamish, Lt., RCETC, A-6
J. C. Beatty, Ens., USNR
H. M. Berg, 2nd Lt., 113th Observation Sqdn., Air Force, USA
C. J. Bergschneider, T/5, 803rd Ordnance Co., USA
H. E. Bergschneider, Maj., Air Force, USA
H. E. Besley, Lt-Col., Corps of Engineers, USA
D. L. Bidwell, Lt. (jg), USNR
Richard Birney, Ens., USNR
J. R. Bishop, Lt. (jg), USNR
J. T. Blakely, Lt., 437th C. A. Bn., USA
W. D. Bland, Jr., Capt., Tank Bn., USA
C. W. Bockhop, 2nd Lt., Field Artillery, USA
L. W. Bonhorst, A/S, USNR
C. R. Boone, Pvt., officer candidate school, USN
J. S. Boyd, Lt. (jg), USNR
C. W. Bracher, 1st Lt., Field Artillery, USA
R. B. Broaddus, Maj., Army Air Force, USA
O. K. Brown, Lt., AAF, USA
H. F. Bruns, USA
E. C. Buie, Maj., Ordnance Dept., USA
B. G. Burr, Maj., AAF, USA
J. C. Bursik, Ens., USN
G. A. Burson, Jr., Lt., 11th A.R., 10th Div., USA
C. J. Bush, 1st Lt., Field Artillery, USA
E. D. Butler, 1st Lt., 202 Inf. Bn., USA
L. E. Buxton, A/S, USNR
H. C. Campbell, Capt., Air Force, USA
W. M. Carleton, Ens., USNR
C. E. Carlson, Pvt., Ordnance Dept., USA
F. C. Chambers, Capt., Ordnance Dept., USA
T. Cleaver, Capt., Coast Artillery (AA), USA
K. R. Cline, Capt., Coast Artillery (AA), USA
L. Collins, Lt.-Col., G.S.C., Headquarters 2nd Armored Div., USA
S. A. Collins, Maj., Corps of Engineers, USA
E. O. Cone, 1st Lt., Corps of Engineers, USA
W. A. Cornwell, Lt. (jg), Sqdn. 8-B, Air Force, USNR
H. F. Corson, Cpl., USA
W. H. Cox, 1st Lt., 150th Infantry, USA
F. M. Crawford, Maj., 75th Coast Artillery (AA), USA
R. D. Crist, Capt., Air Force, USA
M. G. Cropsey, Maj., Main Bn., 10th Armored Div., USA
G. E. Cubberly, Capt., Corps of Engineers, USA
J. F. Cykler, Ens., USNR
A. C. Dale, 2nd Lt., Air Force, USA
R. S. Danio, Sgt., 68th Troop Carrier Sqdn., Air Force, USA
R. M. Dill, 1st Lt., Quartermaster Corps, USA
P. C. Dillon, Capt., 82nd Field Artillery, USA
J. R. Dodge, USA
C. G. E. Downing, Lt., RCOC-TC
D. L. DuBois, Lt., (jg) USNR
A. A. Dudley, 2nd Lt., Corps of Engineers, USA
R. F. Dudley, Lt., AAFTS, USA
R. A. Duncan, Capt., Corps of Engineers, USA
G. H. Dunkelberg, Capt., 321st Field Artillery, USA
A. K. Edwards, Ens., C.E.C., USNR
J. B. Elrod, 2nd Lt., Army Air Force, USA
B. L. Embry, Ens., D-V (s), USNR
J. F. Eppes, 1st Lt., Ordnance Dept., USA
J. W. Evans, Jr., Pvt., 304th Engr. Combat Bn., USA
R. L. Ewart, A/C, Air Force, USA
I. S. Exley, Pvt., Infantry, USA
G. T. Finlinson, Pvt., Corps of Engineers, USA
G. R. Fisher, 1st Lt., Corps of Engineers, USA
C. C. Fisk, 2nd Lt., AAF, USA
P. H. Fitzgerald, 1st Lt., Coast Artillery (AA), USA
T. S. Forsaith, Lt., Royal Canadian Engineers
J. I. Fredregill, Capt., Ordnance Dept., USA
R. K. Frevert, Lt., Air Force, USA
W. R. Friberg, Maj., Hdg., ASFTC, USA
R. R. Garrard, 2nd Lt., Air Force, USA
W. E. Garrard, 2nd Lt., Air Force Training Det., USA
S. B. George, Capt., Quartermaster Corps, USA
L. M. Graves, Capt., 607 T.D. Bn., USA (Honorably discharged)
H. E. Gray, Capt., Signal Corps, USA
T. E. Griffin, 2nd Lt., Signal Corps, USA
Rene Guillou, First Eng., USA
O. C. Hansen, 1st Lt., Field Artillery, USA
M. J. Happe, Capt., Corps of Engineers, USA
P. E. Harbison, Pvt., Air Force, USA
F. E. Hardisty, Capt., USA
G. M. Hardy, Lt. (jg), USNR
H. T. Hargrave, 2nd Lt., Royal Canadian Air Corps
J. W. Harwell, 1st Lt., Corps of Engineers, USA
A. G. Hazen, 1st Lt., Corps of Engineers, USA
G. L. Hazen, Capt., Corps of Engineers, USA
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E. A. Hodges, Capt., Field Artillery, USA
L. H. Hodges, 2nd Lt., USA
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Lt. John E. Cottingham — January 27, 1943
Lt. James E. McKay — January 28, 1943
Lt. Samuel J. Baldwin — January 13, 1943
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Using ingenuity and "know-how" born of long experience, automotive engineers designed the phenomenally successful transport equipment that now speeds the United Nations on the road to Victory.

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Proposed Program for Agricultural Engineering Extension

THE A.S.A.E. Committee on Extension would (1) urge all extension agricultural engineers to make special effort to use the unusual opportunity offered the group to render a truly worthwhile service to farmers in connection with their efforts to attain production goals and (2) stress the importance of postwar planning.

The Committee believes that in order to be most effective in supporting current and postwar programs extension agricultural engineers as a group should do four important things, namely:

1 Utilize the facilities of all organization, both public service and private industry, for carrying to every individual farmer information on farm practices, equipment, materials, etc., which will enable him to increase production on his farm. (In the opinion of the Committee much can be accomplished by enlisting the cooperation of local organizations and individuals, such as community clubs, 4-H clubs, vocational agriculture departments, farm equipment dealers, farm contractors, oil truck salesmen, etc.)

2 Make more general use and exchange of educational literature and visual material. It is important in this connection that the illustrating of such literature be improved and simplified to be more usable by the farmer. It is desirable to avoid needless and costly duplication; therefore, a greater effort should be made toward publishing literature and developing visual material cooperatively, both between public service agencies and between such agencies and allied industry.

3 Evaluate research needs and recommend them to research directors of state, federal and private agencies, and collaborate with committees of the technical divisions of the Society.

4 Stress long-time objectives. Place increased emphasis on the *social* implications of the agricultural engineer's work in postwar planning to the end that the highest general well-being of the farm family be achieved. (That will be realized only through the fullest cooperation with such other groups as farm management, home economics, plant and livestock industries, rural life organizations and others.)

The Committee on Extension feels that among other responsibilities it should assume that of keeping agricultural engineering extension before the deans of agriculture and directors of extension periodically as started in December, 1943, and to develop cooperation with commercial extension engineers and industrial concerns. (At the Chicago extension agricultural engineers' conference in December, 1943, certain recommendations pertinent to the 1944 farm equipment program were drafted and adopted. These recommendations were submitted to the USDA Extension Service, and from there were sent to all state extension directors.)

In pursuance of that policy, the Committee submits the following "Outline of Proposed Extension Projects in Agricultural Engineering." This outline together with the foregoing recommendations are submitted to the Society as only a progress report of the 1943-44 Committee on Extension. The new committee should continue with further explorations and developments.

A report of the Committee on Extension of the American Society of Agricultural Engineers — H. E. Everett, J. P. Fairbank, H. J. Gallagher, E. L. Hansen, R. C. Hay, C. N. Hinkle, C. V. Phagan, and C. H. Van Vlack (chairman). May 26, 1944.

PROPOSED EXTENSION PROJECTS IN AGRICULTURAL ENGINEERING
(Suggested by replies from questionnaires addressed to all extension agricultural engineers)

I Current and Duration Phases of Agricultural Engineering Extension
- (A) Farm Machinery and Equipment
  - 1 Adjustment, repair and management
  - 2 Labor-saving equipment
- (B) Household Equipment
  - 1 Sewing machines
  - 2 Pressure cookers
  - 3 Home equipment repair
- (C) Buildings (Farm Structures)
  - 1 Reconditioning and painting
  - 2 Plan services
  - 3 Farm livestock production equipment

(Continued)

Buy More War Bonds

HOG FARM STRUCTURES OF CONCRETE

Agricultural engineers have shown hundreds of farmers how concrete hog houses and feeding floors reduce losses from swine diseases, save feed and produce marketable pigs faster.

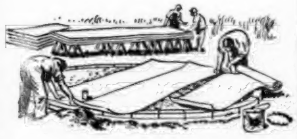
Now, raising hogs on concrete, an idea which has helped the war food program, has been adopted by many of the most successful hog raisers.

Our engineers, specialists in farm uses of concrete, will be glad to help you in designing a model hog raising plant, or on any other concrete farm building design or construction problem. Our illustrated booklet, *"Modern Hog Farm Improvements"* is free in the United States and Canada.

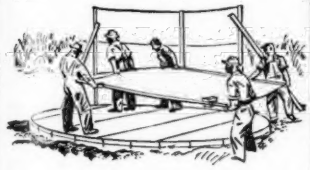
PORTLAND CEMENT ASSOCIATION
Dept. 6-1, 33 W. Grand Ave., Chicago 10, Ill.

A national organization to improve and extend the uses of concrete . . . through scientific research and engineering field work

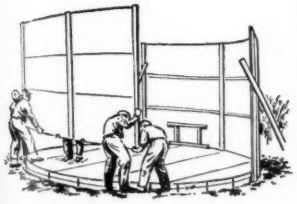
Leveling earth fill inside foundation blocks.



Covering fill with heavy asphalt roll roofing.



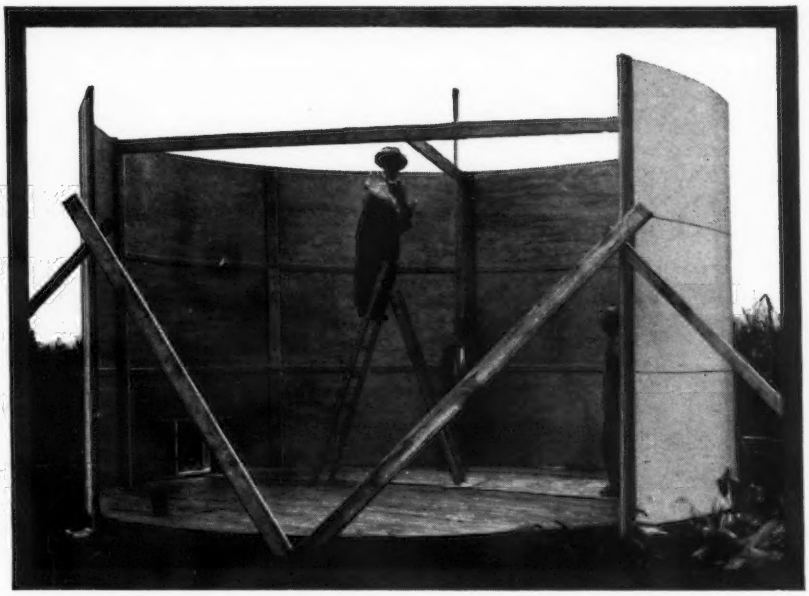
First wall in place, second ready to go up.



Two wall sections in place. Reinforced outlet door can be seen.

Conical roof being built up of 4′ plywood segments.

Completed 3200 bushel grain storage bin. A tight, sturdy structure which is stimulating improved post-war designs, it has served its purpose admirably over two seasons.



Douglas Fir Plywood Grain Bin of 3200 Bushel Capacity

BRIEF SPECIFICATIONS

SIZE: 20 foot diameter, 12 foot height.
CAPACITY: 3200 bushels.
FOUNDATION: Concrete blocks held by wire around perimeter.
SILL: 4″x4″ fir dimension bandsawed to shape in 4 foot segments.
FLOOR: Earth fill covered with heavy asphalt roll roofing.
WALLS: 1/4″ Moisture-resistant Douglas fir plywood (see explanation in text) placed horizontally for maximum strength against lateral pressure. Horizontal joints covered with 1/4″ plywood strip 4″ wide glued and nailed to inside of panels. Vertical joints glued and nailed between 1/4″ plywood strip 6″ wide and 2″x6″ stud. No intermediate studs. Alternate studs placed on outside and extended 3′ 6″ into ground for anchor. Urea resin glue. Nails 6d common spaced 4″ o.c. or closer. Lower panel overhangs 2″ and nails to sill.
ROOF: Light weight conical frame of 1″x4″ rafters 2′ o.c. attached to laminated 2″x4″ plate bandsawed to shape and to circular plywood ring of 18″ diameter at apex. Joints covered with 3″ plywood strips.
PAINT: Exterior walls and roof given two coats exterior lead and oil paint.

DOUGLAS FIR PLYWOOD
Real Lumber
MADE LARGER, LIGHTER
SPLIT-PROOF
STRONGER

This bin was built at the Agricultural Engineering Farm of Iowa State College in August 1942 to prove the adequacy of design and glued construction. Due to the prevailing material shortage, only moisture-resistant plywood was available. The project was, therefore, primarily a design-construction study.

Design computations indicated a large safety factor for the 1/4-inch thick walls with panels placed horizontally so the two face veneers acted in tension. Special attention was given to gluing and bolting the frame around the 2′x2′ outlet door to distribute stress concentrations due to the cut-out.

A unit stress value of 30 psi for the glued area was used in designing the vertical connector plates. Nailing pressure only was used for glued joints, 6d common nails being driven on about 3″ centers through the plates and wall panels into the 2″x6″ studs.

Roof segments were cut with little waste from standard size panels. The laminated circle for framing the roof apex opening was built up of four thicknesses of 1/4″ plywood strips cut 12″ wide with the face grain running across the strips for ease in bending.

The structure, a site prefabrication job, was built without jigs or special equipment. Carpenters had no previous experience in this type of construction. Wall panels were assembled in 12′x16′ units before erection.

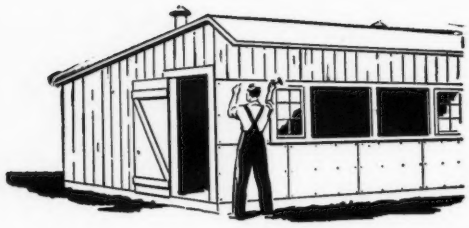
Construction costs, including painting, computed at local retail prices for materials and carpenter day wages, totaled approximately 9 cents per bushel capacity. Use of EXTERIOR type Douglas fir plywood would increase this unit cost very moderately.

Credit is due representatives of the U. S. D. A. Bureau of Plant Industry, Soils and Agricultural Engineering; the Commodity Credit Corporation, and Iowa State College for assistance in design and construction.

DOUGLAS FIR PLYWOOD ASSOCIATION
Tacoma 2, Washington

GENUINE DOUGLAS FIR PLYFORM Concrete Form Panel D.F.P.A. INSPECTED
GENUINE PLYWALL Douglas Fir Plywood WALLBOARD D.F.P.A. INSPECTED
SPECIFY DOUGLAS FIR PLYWOOD BY THESE "GRADE TRADE-MARKS"
PLYPANEL D.F.P.A.
EXT.-D.F.P.A.
GENUINE PLYSCORD SHEATHING D.F.P.A. INSPECTED

Materials ENGINEERED for Farm Uses



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These time-proved building materials have long been used for farm construction, maintenance and repair. Replacing hard-to-get materials, many Flintkote products offer special advantages for farm application, protection from fire, weather and wear and the attacks of insects and rodents.

Consultation and advice on farm construction problems is readily available from the Flintkote Agricultural Engineering Department. Please address your inquiries to the nearest branch office.

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II For Development Through the Duration
- (A) Farm Machinery and Equipment
  - 1 Machinery management
  - 2 Maintenance
- (B) Buildings
  - 1 Use of non-lumber materials
  - 2 Emphasis on evaluation of existing buildings in view of restoration, conversion, or salvaging for materials
  - 3 Multipurpose service structures
  - 4 Farm home planning for *remodeling, painting, reconditioning* and postwar construction
- (C) Rural Electrification
  - 1 Planning for postwar extensions and uses
  - 2 Maintenance and management
  - 3 Use to save man power
- (D) Soil and Water Management
  - 1 For increased production
  - 2 Maximum production without serious destruction of resources

III Postwar Phases of Agricultural Engineering Extension
- (A) Postwar Problems
  - 1 Improper and unwise selection of machinery, equipment, and service buildings due to removal of rationing, readjustments, and high buying power. (A good example is in haying equipment—chopping, hay silage, mow curing, one-man balers, crushers, buck rakes, etc.)
  - 2 Farm buildings obsolete and in poor state of repair due to changes in farm practices and operations and lack of maintenance for the past 20 years. Presents the problem of advisability of remodeling or rebuilding and painting
  - 3 Use of new materials and equipment will influence new design of buildings
  - 4 Many farm homes are obsolete, in poor state of repair, and not conducive to a high standard of living on the farm
  - 5 It will be even more important that we reach and cooperate with the greatly expanded commercial interests developing the farm market to assure adequate standards and maximum well-being of the farm family
  - 6 It will be our responsibility to overcome neglect and lack of interest in improved living conditions on the farm in spite of favorable financial conditions

IV Objectives for Postwar Period
- (A) To develop and promote such activities which will contribute most to:
  - 1 Profitable employment on farms
  - 2 Rehabilitation or improvement of physical resources
  - 3 Essential and desirable improvement for better living by:
    - (a) Increasing farm efficiency
    - (b) Remodeling, reconditioning and painting farm service structures
    - (c) Developing postwar housing plans for new houses and remodeling
    - (d) Developing rural electrification to reach more farm homes and increasing its usefulness
    - (e) Managing soil and water, including irrigation and drainage to maintain production without serious depletion
    - (f) Utilization of surplus war equipment and supplies

V Literature Needed
- (A) Farm Machinery
  - 1 Repair methods
  - 2 Repair and adjustment information on each farm machine
  - 3 Large charts
  - 4 Tractor maintenance, efficient operation
  - 5 Homemade machines and equipment
  - 6 Labor efficiency in hay making
  - 7 Fuels, oils and lubricants* (Arizona)
  - 8 Planning shop facilities and equipment
  - 9 Safety
  - 10 Fire-fighting equipment
- (B) Buildings
  - 1 Functional requirements of service buildings
    - (a) Insulation and ventilation
    - (b) Sanitation
    - (c) Poultry housing

(Continued on page 236)

*Indicates literature on this subject is now in preparation.

Specifications Read . . .

UNITED AIR CLEANERS

One of the most unique military machines American inventive genius has created for today's highly mechanized warfare is the M-4 Military Tractor. Built to haul the heaviest artillery swiftly over every conceivable kind of terrain — shell holes and ditches, loose sand, deep mud and mountainous hillsides — this powerful prime mover was developed by the Allis-Chalmers Tractor Division in cooperation with the Army Ordnance Department.

A specially engineered United Oil Bath Air Cleaner and precleaner installed in this combat unit affords maximum protection to the vital internal parts of the power unit — against excessive dust, smoke and other abrasive air particles present in combat areas.

This is one of 260 models of United air cleaners for all types and sizes of internal combustion engines. Our many years of experience plus knowledge gained in war-developed installations will be put to effective use in providing higher standards of protection for new engines coming tomorrow.

We invite you to draw on this experience in developing proper installations in your new designs.

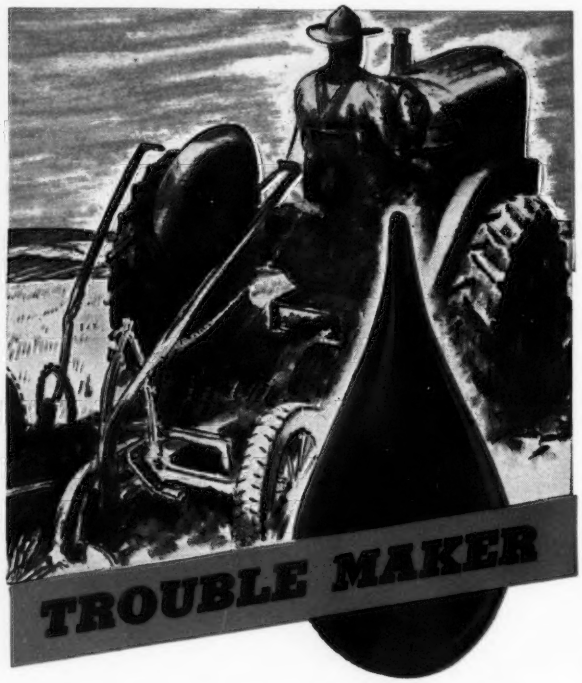
UNITED GUARANTEED V PRODUCTS

UNITED SPECIALTIES COMPANY

UNITED AIR CLEANER DIVISION • CHICAGO 28, ILLINOIS

MITCHELL DIVISION • PHILADELPHIA 36, PA.

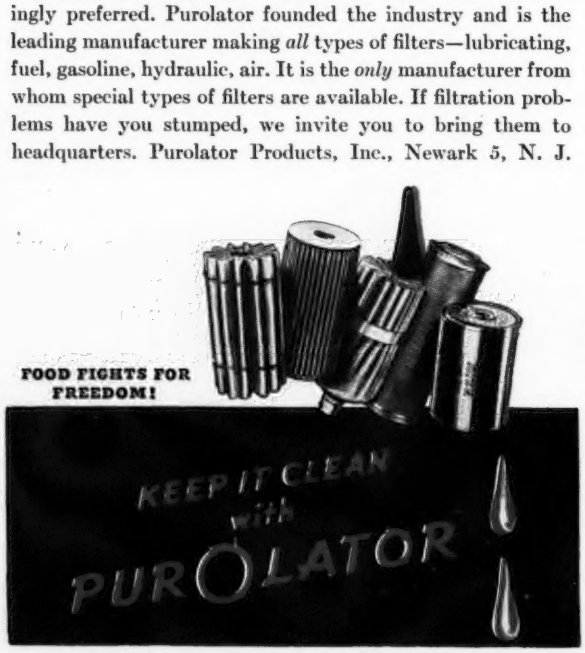
AIR CLEANERS ★ METAL STAMPINGS ★ HIGH PRESSURE HOSE CLAMPS ★ IGNITION SWITCHES ★ ROLLED SHAPES ★ DOVETAILS



Tractor manufacturers recognize the danger of sludge. They know that dirt and grime, mixed with crank case dilution, form an emulsion which sometimes appears as a sticky mass, again as a clear or colored "varnish." This emulsion gets into oil lines, clogs ring grooves, fastens onto piston and valve stems, causes an endless variety of troubles.

To remove engine dirt and prevent sludge formation, tractor manufacturers install oil filters. In the great majority of cases the filters are Purolators, *because Purolators keep oil cleaner longer.*

It's not surprising that Purolator filters are so overwhelmingly preferred. Purolator founded the industry and is the leading manufacturer making *all* types of filters—lubricating, fuel, gasoline, hydraulic, air. It is the *only* manufacturer from whom special types of filters are available. If filtration problems have you stumped, we invite you to bring them to headquarters. Purolator Products, Inc., Newark 5, N. J.



NEWS SECTION

A.S.A.E. Meetings Calendar

June 19 to 21 — Annual Meeting, Hotel Schroeder, Milwaukee, Wis.

December 11 to 13 — Fall Meeting, Stevens Hotel, Chicago.

Tennessee Section Meeting

THE Tennessee State Section of the American Society of Agricultural Engineers held a most enjoyable meeting at Pigeon Forge, located near Knoxville, on May 27.

Members of the Section including many of their wives and children and other visitors, in attendance at the meeting, enjoyed a very delightful outing as well as a very interesting and educational program which had been prepared by the program committee. One of the features of the program was motion pictures presented by Joe Elliott of the Tennessee Agricultural Extension Service.

Personals of A.S.A.E. Members

George W. Crowther has resigned as assistant agricultural engineer, extension service, University of Maine, to accept a position as assistant professor and extension specialist in agricultural engineering at the University of Connecticut, Storrs.

Ben L. Hagglund, for many years a district representative and more recently assistant division sales manager, was recently appointed sales manager of the western division of the Caterpillar Tractor Company.

C. L. Hamilton has accepted the position of agricultural engineer of the farm and home safety division of the National Safety Council at Chicago, having resigned as chief, farm construction section, Office of Materials and Facilities, War Food Administration.

Verne R. Hillman is now engaged as agricultural engineer by the State Soil Conservation Committee of Virginia and will be in charge of that organization's machinery and equipment program. For several years Mr. Hillman was area conservationist of the U. S. Soil Conservation Service at Danville, Va., and more recently he has been headquartered at the SCS regional office at Spartanburg, S. C., in the capacity of zone engineer for the states of Kentucky and Tennessee. He was employed by the agricultural engineering department of Virginia Polytechnic Institute for nine years before joining the SCS organization in 1935.

Mack M. Jones, professor of agricultural engineering, University of Missouri, is author of Circular 284, entitled "Building a Sweep Rake," issued recently by the University of Missouri.

Albert F. Keegan is now employed by C. B. Stenvall, mechanical engineer, and is in charge of the drafting room and assistant on design of special machinery which the organization builds. More recently he was employed as junior mechanical engineer by Walter D. Teague, a firm of industrial engineers.

Ira L. Knox has resigned as associate agricultural engineer, division of electrical development, Tennessee Valley Authority, to become associated with F. W. Faxon in the realty business at Memphis, Tenn.

John W. Randolph is now engaged as agricultural engineer of the United States Sugar Corporation, and is located at Clewiston, Florida. His work is on special problems in the mechanization of the production and harvesting of sweet potatoes. His company plans to produce 18,000 acres of sweet potatoes for making starch an other products. A new starch mill now under construction is adjacent to the raw sugar mill which normally grinds the cane from approximately 30,0000 acres of muck land. Mr. Randolph was previously employed as an agricultural engineer (BPISAE) U. S. Department of Agriculture.

John A. Scholten, research engineer, Forest Products Laboratory, U. S. Forest Service, is author of Technical Bulletin 865T, entitled "Timber-Connector Joints, Their Strength and Design," recently announced by the U. S. Department of Agriculture.

Ray I. Shaul, chief in farm machinery, agricultural engineering department, University of Illinois, is author of Circular No. 574, entitled "Relief from Tractor Troubles," prepared in cooperation with the vocational agriculture service of the University and representatives of the farm equipment industry.

(Continued on page 234)

TO REALLY PRODUCE, a farmer needs good equipment and good buildings. That means steel—and lots of it. Take buildings, for example. Modern sanitary barns, good silos, tight sheds, grain storage bins are all made better and longer-lasting when built with steel. The government understands this and the relation of good buildings to large food production. So we are now permitted to manufacture a limited quantity of U·S·S Steel Roofing and Siding Sheets. And our dealers are doing their best to distribute them where they are most needed.

Machinery and equipment also require good steel. For these purposes, the suitability of U·S·S Steels and Steel Products is widely recognized. So is the ability of our metallurgists and engineers. Their laboratory research and work in the designing room have given us the widest possible range of steels . . . and the knowledge of how best to use them. And the improved steels they have developed for war uses will be available for better farm equipment and structures when peacetime comes.

Whether you are a farm machinery manufacturer or a farm structures engineer, the experience of our technical men can be of practical help in solving your present or future problems.

Why not write us today? We shall be glad to work with you.

CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*
AMERICAN STEEL & WIRE COMPANY, *Cleveland, Chicago and New York*
United States Steel Export Company, New York

U·S·S Steel Roofing and Siding

A favorite with American Farmers

UNITED STATES STEEL

To Protect Wood

Against Rot and Insect Borers

Specify

CUPRINOL

For Wood

Cuprinol is a Danish formula of over 30 years effective use in Europe and the Tropics, and already extensively recognized in this country.

Where pressure treatment of wood is unavailable or too costly Cuprinol meets a long felt need on the farm, for it is applied merely by brush, spray or a quick dip. It may be used as a priming coat or by itself. It does not irritate the skin nor burn the clothes.

Cuprinol treated wood is harmless to ensilage, to plants, to poultry and to animals.

Many successful tests have been completed in important Agricultural Colleges. One of these, treating flats, showed that "there was a root concentration ½" to 1" above the bottom of the treated flat instead of between the soil and the wood. A slight monetary savings is realized on flats which are treated with Cuprinol, over a period of years".

Moreover, in places where rot and insect borers are most severe, particularly in the Tropics, Cuprinol is being used in the War effort to give protection to wood, fabrics and cordage on both land and sea.

Cuprinol is sold in quarts, gallons, 5 gallon drums and 50 gallon drums, and provides a practical and economical method of preserving wood in all farm construction. Cuprinol is also made in types for the preservation of Fabrics, and of Rope.

Inquiries from Agricultural Engineers are invited

CUPRINOL, Inc. **29 Spring Lane, Boston 9, Mass.**

Personals of A.S.A.E. Members

(Continued from page 232)

Mason Vaugh, agricultural engineer at the Allahabad Agricultural Institute in India, is on leave from his duties and will spend about one year in the United States.

Robert G. White, extension agricultural engineer, is one of the authors of Extension Circular 174, entitled "Terracing with a Moldboard Ploy," and also one of the authors (*John M. Ferguson,* also extension agricultural engineer, being another) of Extension Circular 167, entitled "Contour Farming," both circulars having just been released by Kansas State College.

W. Eugene White, has resigned as district manager, Consumers Public Power District, at Lexington, Nebr., to become owner and operator of a retail variety store at Whittier, Calif.

Earl R. Young, assistant professor of agricultural engineering, University of Kentucky, is participating in the preparation of a series on farm operations in the farm work simplification project at the Kentucky Agricultural Experiment Station. The series will deal with operations in the production of burley tobacco, including pulling the plants, transplanting by hand and machine, cutting and housing, and stripping. Extension bulletins are in process of preparation on these operations.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

L. A. Bixby, automotive sales manager, Clark Equipment Company. (Mail) 914 So. 3rd St., Niles, Mich.

R. W. C. Borland, manager, farm implement and tractor tire department, Dominion Rubber Company, Kitchener, Ontario, Canada.

N. W. Burke, field representative, Louden Machinery Co., Fairfield, Iowa.

Maurice B. Cox, assistant agricultural engineer, Soil Conservation Service, USDA. (Mail) P.O. Box 465, Guthrie, Okla.

John W. Dobie, rural electric investigator, Washington Committee on the Relation of Electricity to Agriculture, State College of Washington, Pullman, Wash. (Mail) 2102 Monroe St.

Richard G. Hall, assistant manager (Washington Branch) International Harvester Co. (Mail) 815 15th Street N.W., Washington 5, D. C.

O. A. Hanke, editor, Poultry Tribune, Mount Morris, Ill. (Mail) Sandstone Bldg.

Lloyd L. Harrold, project supervisor, North Appalachian Experimental Watershed, Soil Conservation Service, USDA. (Mail) 1527 Denman Ave., Coshocton, Ohio.

E. T. Johnson, assistant chief experimental engineer, John Deere Harvester Works. (Mail) 552 26th Avenue, Moline, Ill.

Henry Karrer, engineer, Patterson Water Co., Patterson, Calif. (Mail) P.O. Box 355.

Robert K. MacArthur, associate civil engineer, water conservation and utilization, Farm Security Administration, USDA. (Mail) Newton Project, Woodruff Hall, Logan, Utah.

Frank M. MacFall, associate agricultural engineer, Office of Foreign Agricultural Relations, USDA, Washington, D. C.

Herbert F. Martin, farm development manager, Long Island Lighting Co. (Mail) 118 West Main St., Riverhead, N. Y.

Leon R. McRobert, engineer, Harry Ferguson Inc. (Mail) 827 12th St., Greeley, Colo.

Fred P. Oliver, assistant sales manager, Union Insulating Company, Inc. (Mail) Box 351, Parkersburg, W. Va.

P. S. Rao, technical assistant, Imperial Agricultural Research Institute, New Delhi, India.

W. A. Roberts, vice-president; manager, tractor division, Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.

Kenneth W. Snyder, naval officer's training, U. S. Naval Academy. (Mail) 2310 No. 56th St., Omaha, Nebr.

James Mell Stephens, mold design draftsman, Goodyear Tire & Rubber Co., Akron 6, Ohio. (Mail) 856 Crouse St.

TRANSFER OF GRADE

Roy E. Hayman, in charge of rural electrification, Oklahoma Gas & Electric Co., Oklahoma City, Okla. (Member to Fellow).

The LaFayette—1837. One of the earliest B & O locomotives to haul the trains of the Presidents of the United States.

PREFACE OF A NEW ERA

GM Diesels have the exacting job of hauling B & O's highest-class freight, including trains of perishables and other foodstuffs for the armed forces as well as for civilian markets.

KEEP AMERICA STRONG BUY WAR BONDS

DAY in and day out, General Motors Diesel Locomotives are proving their ability to haul huge loads far, fast, with little attention and at low cost. In any vision of the future of transportation, these tireless giants must loom large. Already they have won a place of rare importance by their unprecedented performance in the work of the railroads at war.

GM
GENERAL MOTORS
DIESEL POWER

LOCOMOTIVES . . . . . ELECTRO-MOTIVE DIVISION, La Grange, Ill.

ENGINES . . 150 to 2000 H.P. . . CLEVELAND DIESEL ENGINE DIVISION, Cleveland, Ohio

ENGINES . . . . 15 to 250 H.P. . . . . DETROIT DIESEL ENGINE DIVISION, Detroit, Mich.

Proposed Extension Program

(Continued from page 230)

(d) Dairy barn construction (f) Beef cattle
(e) Swine (g) Grain and feed storage

2 Literature for rural carpenters
3 Tenant and labor housing* (New Jersey)
4 Descriptive farm building plan lists
(Keeping up to date using timely suggestions)
5 Efficient farmstead arrangement including time studies
6 Use of non-lumber and other non-critical materials
7 Planning farm shop layout and equipment facilities
8 The modern farm house* (Iowa)
(a) Requirements including heating, plumbing, etc.
(b) Remodeling
(c) Reconditioning, painting and decorating
9 Fire prevention
10 Rodent and termite control, etc.
11 Fireproof construction

(C) Electrification
1 Promotion of production uses
(a) Use to conserve man power
(b) Maintenance of electrical equipment

(D) Soil and Water Management Practices
1 Drainage* (Iowa) (P.C.A.)
2 Irrigation
3 Contour farming and terracing*

*Indicates literature on this subject is now in preparation.

Dewater the Wiring

(Continued from page 207)

farm wiring code. Nevertheless, it may be impossible to keep recognized wiring contractors and workmen from making a fetish of the urban code unless there be another code which definitely debars application of the urban code to rural conditions. In the face of unreasonable layouts and costs, farmers are prone to turn to "gyp" or inexperienced wiremen who do a *cheap* job and leave the farm inadequately and perhaps dangerously wired.

We have no panacea for the sickly condition of farm wiring. We suggest as a preliminary step that agricultural engineers actively wrestling with the problem establish an entente cordiale with the insurance companies, notably the farm mutual companies. Similarly harmonious relations might well be fostered with the sundry state regulatory bodies. Every effort should be made to "insulate" farm wiring from racketeer influence. With these precautions, it may be possible to develop materials, practices, and service agencies which will make farm wiring not only safe and adequate, but economic.

Legislation for Drainage Construction

(Continued from page 224)

justified in the case of irrigation it is equally desirable and justifiable in the case of drainage enterprises. The cost per acre of drainage improvements in the average drainage enterprise is but a fraction of that of the average for irrigation improvements, and the drainage enterprises are located in developed areas or are near centers of population, which reduces transportation costs for products grown. Such federal assistance would simplify problems in connection with financing drainage enterprises, and would be a boon to many such enterprises that find it necessary to rehabilitate their ditches and drains which have been allowed to deteriorate during the depression through which the country has recently passed.

In conclusion, it is my opinion that much of the difficulty, delay and neglect of maintenance found in connection with drainage enterprises is due not so much to faults in the law as to lack of ability or to inattention on the part of those administering the district's affairs. When landowners realize fully that a drainage project may be sound from an engineering and economical standpoint, and still fail because the administration of its affairs has fallen into incompetent hands, great care will be exercised in selecting the management. It requires something more than a good project to make a success. Poor management will wreck the best drainage enterprise as surely as it will a commercial or industrial undertaking.

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There's Another
DISC WHEEL for You!
Pictured above is a view of one of our huge Hydraulic Fast Traverse Presses, which turns out Disc Wheels of all sizes and varieties at high speed. This equipment is further assurance to you of quality Wheels at economical cost. Write us today for Illustrated Bulletins and full details.
EWC WHEELS
Electric Wheel Co., Dept. AE Quincy, Ill.

You can't feed America ....BY HAND

ONLY with Modern Production Machinery can farmers feed our fighting men, and the folks at home.

The most modern of all farm machinery is the FOX Pick-up Hay and Forage Harvester with its Pick-up, Mower Bar and Corn Harvesting Units. This machine is to the farmer what the production line is to the manufacturer.

☆ ☆ ☆

The FOX is built by the Pioneers of Modern Forage Harvesting. We are all sold out for this year but write us; we will be glad to tell you all about this marvelous machine.

R. G. Krueger
Secretary

FOX

The FOX Hay and Forage Harvester

—will pick up, chop and load, ready for the mow or stack, 2 tons of dry hay in 12 minutes.

—will mow, chop and load, in one operation, over 200 tons of grass silage a day.

—will cut corn of any height, chop it into silage, load it into wagons ready for the silo, all in one operation.

FOX RIVER TRACTOR COMPANY

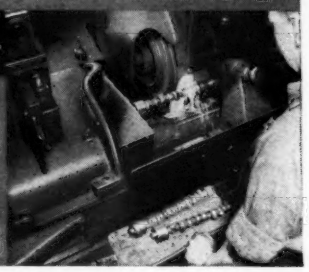
1864 NORTH RANKIN STREET

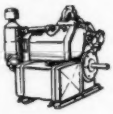
APPLETON FOX WISCONSIN

Pioneers of Modern Forage Harvesting

PRECISION-GROUND CAMSHAFTS

another "HIDDEN VALUE" in all WISCONSIN Air-Cooled ENGINES





The "Camomatic" is another of those more-than-human machines that help to put heavy-duty serviceability and smooth-running efficiency into every Wisconsin Engine.

This machine automatically rough-grinds (and subsequently "smooth-finishes") each and every cam for every Wisconsin Air-Cooled Engine. The grinding wheel finishes cam contour with absolute precision and uniformity. Every camshaft for a given size engine, is exactly like all the other camshafts for all the other engines of that size.

This is another of those features you *don't* "see" . . . but it performs an important service for you *on the job, on your equipment.*

Most H.P. per pound

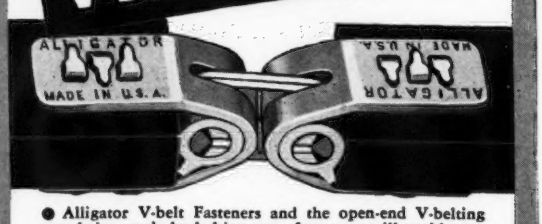
WISCONSIN MOTOR Corporation

MILWAUKEE 14, WISCONSIN, U. S. A.

World's Largest Builders of Heavy-Duty Air-Cooled Engines

Now you can fasten V-belts by using

ALLIGATOR V-BELT FASTENERS



● Alligator V-belt Fasteners and the open-end V-belting now being made by belting manufacturers, will enable you to make up multiple V-belt drives from roll belting. These fasteners have been on the market 9 years and are now being used on a wide variety of drives.

Available for B, C, D sizes of belt for industrial use and 1-in. and 2-in. sizes for railroad use. These fasteners, however, should not be used for repairing endless cord V-belts.

Bulletin V-205 will give you complete details as to where and how these fasteners are used, sizes, list prices, tools and application instructions. A copy will be mailed at your request.

Order from your supply house

FLEXIBLE STEEL LACING COMPANY

4677 Lexington Street, Chicago 44, Illinois

Also sole manufacturers of Alligator Steel Belt Lacing for flat transmission belts and Flexco HD Belt Fasteners and Rip Plates for fastening and repairing conveyor belts.

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RATES: Announcements under the heading "Professional Directory" in AGRICULTURAL ENGINEERING will be inserted at the flat rate of $1.00 per line per issue; 50 cents per line to A.S.A.E. members. Minimum charge, four-line basis. Uniform style setup. Copy must be received by first of month of publication.

New Literature

"ILLUSTRATED TECHNICAL DICTIONARY," edited by Maxim Newmark. Cloth, 6 x 9 inches, 352 pages, well illustrated, $5.00. The Philosophical Library, New York.

This book contains standard technical definitions of current terms in the applied sciences, graphic and industrial arts, and mechanical trades; including air navigation, meteorology, shipbuilding, synthetics and plastics; with illustrations, technical data, and interconversion tables. The plan of this dictionary is to supply a wide and representative selection of officially approved, standard definitions promulgated by various United States engineering, technical, trade and industrial organizations, as well as by government agencies. Because of its standard definitions and wide scope, this work should prove a worth-while reference guide not only to engineering, technical and trade libraries, for whom it is primarily intended, but also to general libraries. Teachers of applied science, engineering, and of vocational and trade subjects will find helpful teaching aids in its illustrations, tables, and descriptions of industrial processes. The technical research worker and the practical shop mechanic will find a great deal of theoretical and practical shop data conveniently arranged for use. Both in aim and execution the dictionary is intended to contribute to the progress and standardization in the field of technical definitions.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

DEVELOPMENT ENGINEERS AND DRAFTSMEN for agricultural equipment wanted for plant in Middle Atlantic Section. Factory in region almost devoid of equipment manufacturing but with excellent marketing possibilities for certain badly needed new products. Good salaries will be paid in proper proportion to experience and ability. In writing please give full account of education, experience, qualifications, draft and family status, and present salary. Include photograph if possible. PO-162

AGRICULTURAL ENGINEERS, preferably with some extension experience in farm structures, wanted by a nationally known manufacturer of building materials to do educational, research and promotional work for districts in New York, Chicago and New Orleans. Excellent opportunity for permanent postwar connection with a well-established, substantial manufacturing organization. Salary open. State education, experience, draft status and geographical preference in first letter. PO-161

RURAL DEPARTMENT MANAGER wanted for permanent employment with an eastern electric utility. Immediate opening for competent college-trained, agricultural engineer with experience in modern business promotional sales methods. Familiarity with Pennsylvania-German farmer customs desirable. Salary open. Write fully. PO-160

(Continued on page 240)

V Sound the Alert!

MANAGEMENT
LABOR

—for the 5th War Loan drive during June and July. The need for the 5th War Loan is immediate, crucial. For impending events may make the 5th the supreme financial effort of the war.

The U. S. Treasury has set the overall goal at $16,000,000,000 — $6,000,000,000 from individuals alone. This is the biggest sum ever asked of the American people—*and it must be raised.*

That's why the U. S. Treasury asks Management and Labor to sit down together and organize—NOW!

For organization—good organization—has been responsible for the excellent showing of the payroll market. And its most important single superiority has been personal solicitation—desk to desk, bench to bench, machine to machine personal solicitation. 71% of all persons on payroll deductions were solicited for the 4th War Loan.

Now, to personal solicitation, add the sales incentive of a definitely established plant quota. Build your campaign around a quota plan. Set up departmental goals. Stress percentage of participation figures. Stimulate group enthusiasm.

In planning your quota campaign, work in close cooperation with the Chairman of your War Finance Committee. Everything is set to make the 5th War Loan drive a huge success—with your help!

(Note: You've read this message. If it doesn't apply to you please see that it reaches the *one* person who can put it in action!)

Here's the Quota Plan:

1. Plant quotas are to be established on the basis of an *average* $100 *cash* (not maturity value) purchase per employee.
2. Regular Payroll Savings deductions made during the drive accounting period will be credited toward the plant quota.
3. 90% of the employees are expected to contribute toward raising the cash quota by buying extra 5th War Loan Bonds: 1—Outright by cash. 2—By extra installment deductions. 3—By extra installment deductions plus cash.

Example: **JOHN DOE Mfg. Co.** — 1,000 Employees

1,000 employees x $100 Regular Payroll deductions during the eight weekly payroll Accounting Periods of June and July = $100,000 Cash Quota

30,000 / $70,000 (to be raised by sales of extra Bonds to at least 900 employees)

ORGANIZE • SOLICIT • DELIVER

The Treasury Department acknowledges with appreciation the publication of this message by

AGRICULTURAL ENGINEERING

★ ★ *This is an official U.S. Treasury advertisement—prepared under the auspices of Treasury Department and War Advertising Council.* ★ ★

He Drives a Weapon

HERE at home, in history's greatest battle for FOOD, every farm machine is mobilized. This year every tractor operator drives a weapon in the war for Victory and Freedom—and the greatest of these weapons is FARMALL All-Purpose Power.

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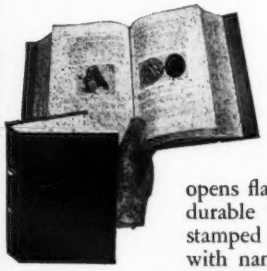
A Handsome, Permanent Binder *for* AGRICULTURAL ENGINEERING



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The ONLY binder that opens flat as a bound book! Made of durable imitation leather, nicely stamped on front cover and backbone, with name of journal and year and volume number, it will preserve your journals permanently. Each cover holds 12 issues (one volume). Do your own binding at home in a few minutes. Instructions easy to follow. Mail coupon for full information, or binder on 10-day free trial.

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234 West Larned St., Detroit, Mich.

Mail postpaid.....*binders for Agricultural Engineering for years*.....
Will remit in 10 *days or return binders collect.*

Name.....

Address.....

City.....State.....

EMPLOYMENT BULLETIN

(Continued from page 238)

AGRICULTURAL ENGINEER is wanted by a nationally known building material manufacturer to assist in farm building design and research and for product promotion and educational work in farm field. An outstanding opportunity for a man with ambition, initiative and ideas to establish a sound and attractive future for himself with an excellent firm. Position requires considerable travelling. Write fully in first letter stating salary requirements. PO-158

AGRICULTURAL ENGINEER with irrigation engineering experience in Italy or with experience under comparable conditions in the southern part of United States is wanted by a federal government agency. Applications should not be in draft classification in which they are likely to be called. A highly competent man able to advise local government authorities concerning the relative urgency of various engineering projects is wanted. Write giving full particulars in first letter. PO-157

REGIONAL SERVICE MANAGER seeking postwar security is wanted by well-known, fast-growing manufacturer of farm tractors and implements who is expanding his organization to prepare for postwar opportunity. Man needed to contact distributors to see that factory service policies are inaugurated and followed through. Must be able to command respect; must know farm implements, their use, care and maintenance and be able to pass his knowledge on to others through meetings, training and supervision. Probably college trained with practical experience; married, and between the ages of 30 and 45. Salary open. Write in confidence to Director, Council for Market Development, 1404 Maccabees Bldg., Detroit, Mich.

FARM EQUIPMENT ENGINEERS. National merchandising organization planning large farm equipment program has openings for senior and junior design engineers. Write experience, draft status, salary expected. Replies confidential. PO-155

ENGINEER interested in drainage research wanted. Southern state with large acreage needing drainage plans to begin intensive research program. First letter should give training, experience and references. PO-153

RURAL ELECTRIFICATION SPECIALIST wanted by agricultural college for combination research and extension work. A very progressive southern state with outstanding rural electrification program. Salary commensurate with training, experience and ability. PO-152

AD COPY WRITER wanted. Man with some technical experience who is creative and has the knack of writing simple, forceful copy for industrial and technical advertising is desired. Permanent position and good opportunity for advancement with long-established 4-A advertising agency. Correspondence will be kept confidential. PO-146

ENGINEERS WANTED in our plants in CALIFORNIA, FLORIDA, ILLINOIS and other states. Must have had at least three years' experience in general machine design. Our work is postwar development of machines for use in agriculture and in fruit and vegetable canneries, packing houses, and processing plants. Please give full history, including family, also name of state in which you prefer working, and salary expected — also snapshot of yourself if available. Reply to Food Machinery Corp., San Jose, California.

POSITIONS WANTED

AGRICULTURAL ENGINEER with B. S. degree in agricultural engineering from a southern college, with experience in soil conservation; construction; fire-fighting equipment; farm buildings; equipment, and operation — and a farm owner, is available. A disabled second lieutenant of World War II, and has served as instructor in a U. S. Army motor school. Age 28 years; single; draft status, 4-F. Disability will not interfere with agricultural engineering work. Would like position that includes any part of agricultural engineering (preferably in southern states), but will consider any place if salary and living conditions are right. PW-360

AGRICULTURAL ENGINEER (B. S. in horticulture, B. S. in engineering and M. S. in agricultural education) with 25 years of experience in teaching, extension and research directly in the field of agricultural engineering, and at present extension agricultural engineer and department head, wishes a position where his training and experience will have an outlet in developing a full four-year curriculum, postwar rehabilitation courses, vocational-agriculture training courses, or opening new lines of approach in extension or research. Special ability in visual methods of presenting extension material and in the organization of cooperative extension programs. PW-359